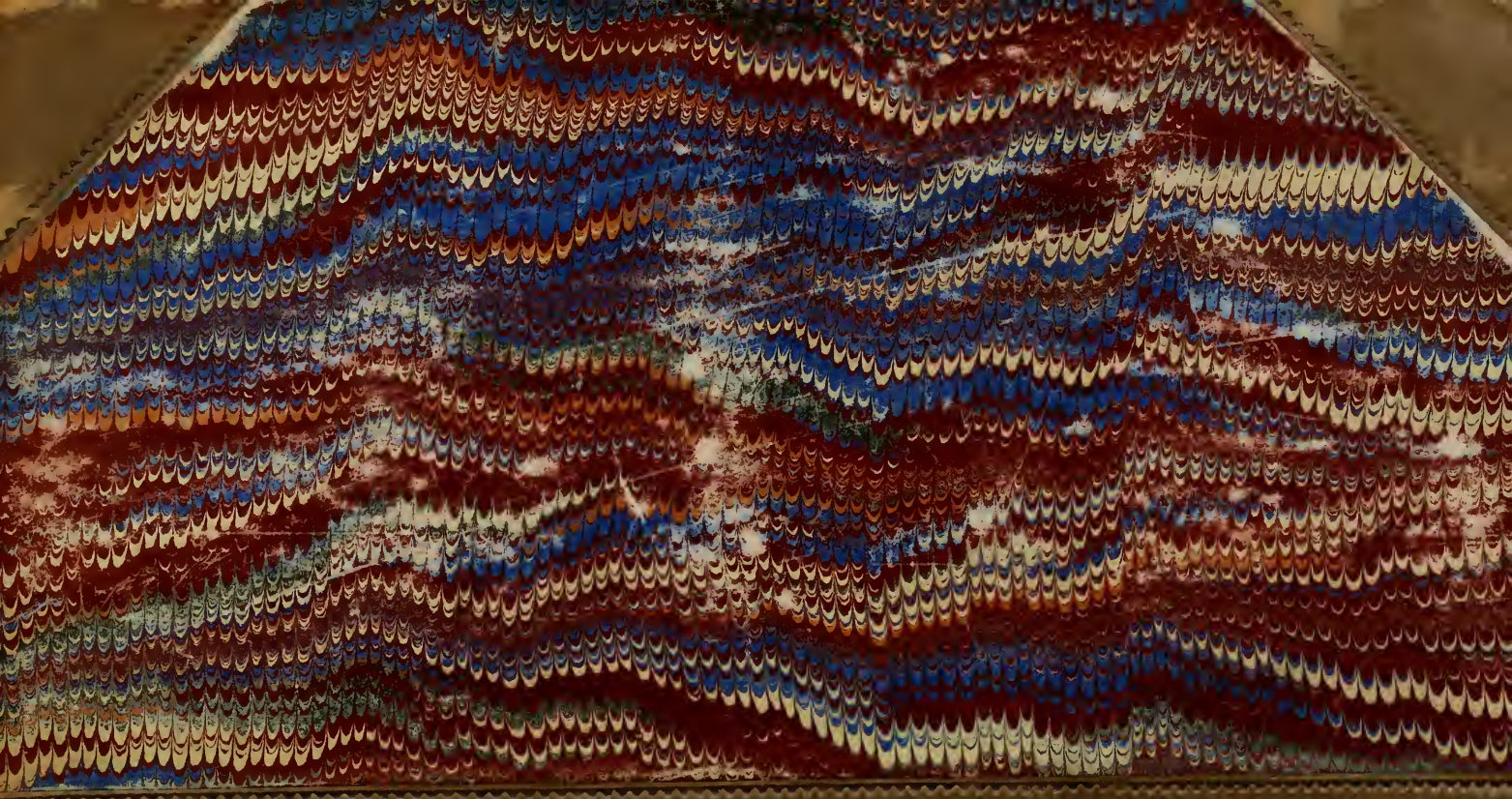

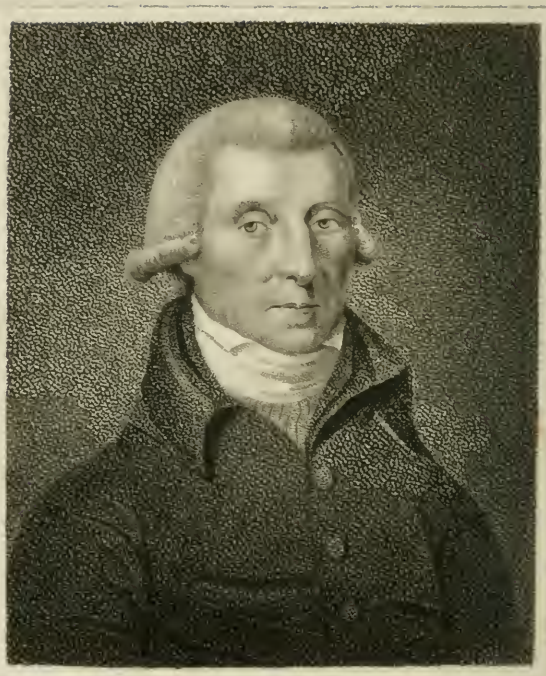

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Richard Kirwan Esq.r
L.L.D. F.R.S. and P.R.I.A.

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THE

PHILOSOPHICAL MAGAZINE:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

AGRICULTURE, MANUFACTURES,

AND

COMMERCE.

BY ALEXANDER TILLOCH,

MEMBER OF THE LONDON PHILOSOPHICAL SOCIETY, ETC. ETC.

"Nec aranearum ſane textus ideo melior, quia ex ſe fila gignunt. Nec noſter vilior quia ex alienis libamus ut apes." JUST. LIPS. *Monit. Polit.* lib. i. cap. 1.

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THE

PHILOSOPHICAL MAGAZINE.

I. *A Reply to Mr.* PLAYFAIR'S *Reflections on Mr.* KIRWAN'S *Refutation of the Huttonian Theory of the Earth. By* RICHARD KIRWAN, *Esq. LL. D. F. R. S. and P. R. I. A.*

DEAR SIR, Dublin, Aug. 24, 1802.

WHEN I first undertook to state some objections to Dr. Hutton's Theory, I little imagined I should call forth such indignation and such illiberal personalities as appeared in the second edition of that work; but however hurt the self-love of an author might have been by an attack on his favourite ideas, I had still less reason to foresee that the same style of hostility would have been persisted in by any person to whom I had given no offence whatsoever. Mr. Playfair's Illustrations of the Huttonian Theory, which I have seen only a few days ago, convince me I was mistaken; he not only attempts to justify the *asperities*, as he calls them, of Dr. Hutton, but aggravates them by new invectives. You need not fear, Sir, that I shall pollute the pages of your journal by the vulgar mode of retaliation; I shall make no reflections on his defence of Dr. Hutton's Theory: enough has been said on that subject. I shall content myself with repelling his unprovoked and unmerited attacks on myself.

To effect this, however, I shall be obliged to state his abusive paragraphs, and thus expose their indecency. It is the only vengeance I shall take; he, probably, will account it none.

Page 119. "To assert, that in the economy of the world we see no mark either of a beginning or an end, is very different from affirming, that the world had no beginning, and will have no end. The first is a conclusion justified by common sense as well as sound philosophy; while the second is a presumptuous and unwarrantable assertion." Here I must deny that the first assertion, namely, that we see no mark of a beginning, is a conclusion justified by common sense and sound philosophy.

Mr. De Luc, Sauſſure, and Dolomieu, were not deficient either in common ſenſe or ſound philoſophy, yet they all aſſert that we may diſcover evident marks of the beginning of the world in its preſent ſtate: nay, Dr. Hutton himſelf allows it, for he judged the actual world to have proceeded from a preceding, and aſſerts that it will have an end. What Mr. Playfair muſt then mean is, that we can ſee no trace of the beginning of this ſucceſſion of worlds. Of ſuch ſucceſſion, it is true, we can trace no beginning, becauſe it is merely fictitious: but while Dr. Hutton aſſerted the reality of ſuch a ſucceſſion without aſſigning any limit, it was natural for me, who was totally unacquainted with him, to infer that he really judged it to have no beginning: this concluſion was ſo natural, that it occurred to others long before I had written on this ſubject. Mr. Williams, his countryman, who was probably acquainted with him, ſays, "That Dr. Hutton aims at eſtabliſhing the belief of the eternity of the world, is evident from the whole drift of his ſyſtem, and from his own words; for he concludes his ſingular Theory with theſe ſingular expreſſions: 'Having in the natural hiſtory of the earth ſeen a ſucceſſion of worlds, we may from this conclude that there is a ſyſtem in nature—in like manner as, from ſeeing the revolutions of the planets, it is concluded that there is a ſyſtem by which they are intended to continue theſe revolutions. But, if the ſucceſſion of worlds is eſtabliſhed in the ſyſtem of nature, it is in vain to look for any thing higher in the origin of the earth. The reſult, therefore, of our preſent inquiry is, that we find no veſtige of a beginning, no proſpect of an end.'"—Williams's Natural Hiſtory of the Mineral Kingdom, Preface, lx.

Now, I aſk what can be the meaning of theſe laſt words, *it is in vain to look for any thing higher in the origin of the earth*. Higher than what? Is it not plain that the meaning is, *higher* than that eſtabliſhed ſucceſſion, of which ſucceſſion we can trace no beginning? And what is a ſucceſſion of which we can trace, and to which we aſſign, no beginning? Now Dr. Hutton, in his firſt edition, no where mentioned that it had a beginning, though ſuch beginning were not apparent on *bare* inſpection of the actual world: was not then his meaning at leaſt ambiguous?

So alſo Mr. Howard, in his learned work on the Structure of the Earth, p. 549, ſays: "Dr. Hutton rejects all time, the operations of his living renovating nature ſcorn all limits: time (ſays he), which meaſures every thing, is to nature endleſs and nothing." But to return to Mr. Playfair: "Mr. Kirwan, in bringing forward this raſh and ill-founded cenſure,

cenſure, was neither animated by the ſpirit nor guided by the maxims of true philoſophy. By the ſpirit of philoſophy he muſt have been induced to reflect, that ſuch *poiſoned* weapons as he was preparing to uſe are hardly ever allowable in ſcientific conteſt, as having a leſs direct tendency to overthrow the ſyſtem than to hurt the perſon of an adverſary, and to wound, perhaps incurably, his mind, his reputation, or his peace." This ſevere cenſure appears to me unmerited: of its liberality I leave others to judge. The mention of preparation of *poiſoned* weapons is perfectly riſible, when it is conſidered that the whole argument is comprehended in ten or twelve lines. If Dr. Hutton had lived either in Spain or Portugal, ſome hurt to his perſon might indeed be apprehended; but in Britain, where Mr. Hume, with impunity, treſpaſſed much more on the received religious principles, no danger could rationally be ſuſpected; and it were idle to think that the reputation of an author could any more be wounded by an inference obviouſly deducible from his principles, than by his own ſtatement of thoſe principles.

Mr. Playfair continues: "By the maxims of philoſophy he (Mr. Kirwan) muſt have been reminded, that in no part of the hiſtory of nature has any mark been diſcovered either of the beginning or end of the preſent *order*." This I deny, in common with thoſe eminent geologiſts already mentioned: clear traces of a *beginning* are found. "By attending to theſe conſiderations Mr. Kirwan would have avoided a very illiberal and ungenerous proceeding; and, however he might have differed from Dr. Hutton as to the *truth* of his opinions, he would not have cenſured their tendency with ſuch raſh and unjuſtifiable ſeverity." I never once conſidered the tendency of his opinions, but merely their direct conſequences; I had nothing to do with their tendency in a mere geological treatiſe.

Page 143. "It has been aſſerted that Dr. Hutton maintained all calcareous matter to be originally of animal formation: this poſition, however, is ſo far from being laid down by Dr. Hutton, that it belongs to an inquiry which he carefully avoided to enter on."

Page 147. "It is nevertheleſs true, that Dr. Hutton ſometimes expreſſed himſelf as if he thought that the preſent calcareous rocks are *all compoſed of animal remains:* this concluſion, however, is more general than the facts warrant, and, from ſome incorrectneſs or ambiguity of language, is certainly more general than he intended." Yet, p. 156, treating of my account of the origin of coal mines, he ſays,

"It is indeed worth while to compare what is said concerning the degradation of mountains in the above quotations (from my Geological Essays) with what is advanced concerning their indestructibility in another passage of the same volume, namely, all mountains are not subject to decay; for instance, scarce any of those that consist of red granite, &c. One can be at no loss about estimating the value of a system in which such gross inconsistencies make a necessary part." Mr. Playfair then finds a gross inconsistency in maintaining that *some* mountains are subject to decay, though *all* mountains are not; facts proved beyond the reach of contradiction; but he can see none in his own two paragraphs.

Page 157. "The quantity of hornblende and siliceous schistus necessary to be decomposed in order to produce the coal strata presently existing, is enormous. It is true that Mr. Kirwan, never at all embarrassed about preserving a similitude between nature as she now is, and as she was heretofore, lays it down, that the part of the primeval mountains, which is worn away, contained much more carbon than the part which is left behind: this, however, is an arbitrary supposition." Not quite arbitrary neither. Mountains before the flood must have been in many respects differently circumstanced from the present; and if at present, after attaining their utmost state of consolidation, many of them are in a state of decay, much more liable to it must they have been then. Hornblende and siliceous schisti are not the only stones that contain carbon, nor are the mountains that present these rocks the only mountains that contain veins of it: many granite mountains also present them. Mr. Playfair, indeed, pays little regard to the authorities I adduce to prove the facts I allege; more impartial readers may possibly pay more.

I shall therefore quote one entitled to the highest credit. Citizen Haüy, in the third volume of his Mineralogy, p. 308 and 309, tells us that anthracite (native mineral carbon loaded with stony matter) belongs exclusively to primitive countries, and that the observations of Mr. Dolomieu prove the existence of carbon independently of animals and vegetables; and that anthracite was, he presumed, nothing more than pure carbon, associated, by accidental causes, with a certain quantity of iron and silex. And Mr. Duhamel has shown in a memoir, approved by the Academy of Sciences, that the argillaceous *strata* that intercede beds of coal are formed of the *detrites* of the neighbouring mountains: *Journal des Mines*, viii. p. 40; and Haüy, iii. p. 319. My system is not then

quite

quite *original*, in the ſarcaſtic ſenſe in which Mr. Playfair applies this word; but it is evident irritation was his ſole purpoſe.

Mr. Playfair adds, "We may alſo object to Mr. Kirwan, that the ſiliceous part of the mountain has not been chemically diſſolved; it has only been abraded and worn away. Mechanical action has reduced the quartz to gravel and ſand, but has not produced on it any chemical change; the carbon, therefore, could not be ſet looſe." Mr. Kirwan has not aſſumed, that carbon was ſet looſe from quartz, though it might have been from ſiliceous ſchiſti and other compound ſtones and rocks: diſintegration is often effected by decompoſition; thus felſpar is converted into argil and ſiliceous particles in many inſtances; but this more frequently happens to ſtones that contain iron.

Page 158. Mr. Playfair, objecting to ſtrata formed by *tranſudation*, aſks what occupied the ſpace of the coal bed before the tranſudation from the upper part of the mountains. The queſtion is unfair, and very ſimilar to the numerous difficulties objected to Dr. Black's diſcovery of fixed air, before its truth was generally acknowledged. A fact is often diſcovered, though the mode of its production be unknown; yet in this caſe the queſtion is eaſily anſwered: the carbonic part of the coal in the mountain of St. George's here alluded to was formed before the upper part of the mountain was formed; it is only the bituminous ingredient that ſubſequently tranſuded from the ſupervenient ſuperior ſtrata; and I ſuppoſe it will be admitted that petrol might penetrate and coaleſce with the carbonaceous part, without floating the upper part of the mountain, as Mr. Playfair ludicrouſly ſuppoſes. This account is ſo much the more probable, as this mountain is formed of a mixed calcareous ſtone abounding in argil; and this ſpecies of calcareous ſtone is of ſecondary formation, as Mr. Haſſenfraz, the author of this memoir, truly remarks, p. 266.

Mr. Playfair concludes by remarking, "that ſuch reaſoning is ſo great a treſpaſs on every principle of common ſenſe, that to beſtow any time on the refutation of it, is, in ſome meaſure, to fall under the ſame cenſure."

Page 171. "If any one aſſerts, as Mr. De Luc has done, that ſand is a chemical depoſit, a certain mode of cryſtallization which quartz ſometimes aſſumes, let him draw the line which ſeparates ſand from gravel; and let him explain why quartz in the form of ſand is not found in mineral veins, in granite, nor in baſalt; that is, in none of the ſituations where the appearances of cryſtallization are moſt general and beſt aſcertained." What is meant by a *chemical depoſit*, I do not

underſtand; but that ſand is ſometimes found regularly cryſtallized is evident, for a whole ſtratum of ſuch ſand has been found at Neuilly: to expect that a ſubſtance expoſed to endleſs friction ſhould always be found in regular cryſtals would be extravagant; that of Neuilly was therefore formed on the ſpot in which it was found.—A vein filled with ſand has been found among the mines of Peregruba in Siberia. Renovantz, Preface, xiii. Gravel and ſand differ only in ſize, and to expect either in granite rocks would be inconſiſtent; but on and beſide granitic mountains gravel very frequently occurs. The cryſtallization of baſalts is ſo far from being aſcertained, that, on the contrary, it has been demonſtrably proved that baſaltic priſms are not cryſtallized, by thoſe that have paid moſt attention to this ſubject.—Romé de Liſle, i. p. 439; Haüy Miner. iv. 476.

Page 180. "The Neptuniſt, who has provided the means of diſſolving the materials of the ſtrata, has only performed half his work, and muſt find it a taſk of equal difficulty to force this powerful menſtruum to part with its ſolution. Mr. Kirwan, aware, in ſome degree, of this difficulty, has attempted to obviate it in a very ſingular way. Firſt, he aſcribes the ſolution of all ſubſtances in water, or in what he calls the *chaotic fluid*, to their being created in a ſtate of the moſt minute diviſion. Next, as to the depoſition, the ſolvent being, as he acknowledges, very inſufficient in quantity, the precipitation took place (he ſays) on that account the more rapidly. If he means by this to ſay, that a precipitation without ſolution would take place the ſooner, the more inadequate the menſtruum was to diſſolve the whole, the propoſition may be true; but it will be of no uſe to explain the cryſtallization of minerals (the very object he had in view), becauſe to cryſtallization it is not a bare ſubſidence of particles ſuſpended in a fluid, but it is a paſſage from chemical ſolution to non-ſolution or inſolubility that is required."

My meaning is clearly ſtated in pages 10 and 11 of my Geological Eſſays, that the ſolids contained in the chaotic fluid were not diſſolved by that fluid, but were contained in that ſtate of minute diviſion to which, if the fluid could of itſelf diſſolve them, they would be reduced; and that, if the quantity of that fluid were inſufficient to hold them in ſolution, this circumſtance would haſten their cryſtallization, precipitation, and depoſition, reſpectively. I did not aſſert that the ſolution was effected by the menſtruum, but, on the contrary, denied it. Mr. Playfair's aſſertion, that cryſtallization is a paſſage from chemical ſolution to non-ſolution or inſolubility, is denied by Bergman: "*Sed non tantum vere ſoluta*

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in aqua determinatas acquirunt formas, verum etiam ni fallor satis attenuata." Bergman, ii. p. 15. It is sufficient that the particles suspended and sufficiently attenuated have an affinity to each other.

Page 22, "Barytic earth is well known to have a stronger attraction to fixed air than common calcareous earth has, so that the carbonate of barytes is able to endure a great degree of heat before its fixed air is expelled: accordingly, when exposed to an increasing heat at a certain temperature, it is brought into fusion, the fixed air still remaining united to it: if the heat be further increased the air is driven off, and the earth loses its fluidity." And, p. 185, "Carrara marble may require a heat of 6300° of Wedgwood to melt it in the open air; but under such a pressure as would retain this gas it cannot be inferred that it might not melt with the heat of a glasshouse furnace. In like manner it may be true that 280 cubic inches of air acting on charcoal cannot effect the fusion of one grain of this marble after its fixed air is driven off from it; but we cannot from thence draw any inference applicable to a case where the carbonic acid is retained, and where the action of heat is independent of atmospheric air." Now, in no experiment with which I am acquainted has native aërated barytes been fused without the expulsion of its air, or union with the earth of the crucible. Dr. Hope, indeed, fused it in a black lead crucible, but found it lost 23 per cent. nearly of its weight; which is the whole, or nearly so, of the air contained, and accordingly it made but a very slight effervescence with marine acid. Hence the position laid down, p. 22, that barolite or native carbonate of barytes may be fused and still retain its fixed air, is founded on no experiment; but from all known experiments the contrary inference is fairly deducible with respect to it, as well as with respect to Carrara marble; nor is there any reason to think that a lower heat, independent of the atmosphere, could have any other effect.

Page 201—203. The fact alluded to, namely, that shells are found incorporated in the body of a rock at a great height near Guancavelica, I have fully stated and explained in a dissertation long since printed, and which accompanies this letter; to which I shall therefore beg leave to refer *.

Page 242. "Mr. Kirwan, in order to account for the magnitude of masses of iron found in Siberia and Peru, supposes that small pieces of native iron have been originally agglutinated by petrol: this is, no doubt, the most singular of all the opinions advanced on the subject; and, as it bor-

* See the next article in the present Number.—Edit.

rows

rows nothing from analogy, it admits of no proof and requires no refutation." I was, however, led into this opinion by analogy with Mr. Gadd's experiments in the 32d volume of the Memoirs of Stockholm; for he tells us, that if clay and calces of iron be plentifully mixed with oil, they will form a mass which will harden even under water. If Mr. Playfair were acquainted with Mr. Chladni's opinion, that these masses were fragments of a broken planet that fell within the sphere of attraction of our globe, he might possibly think it the most *singular*; yet even so, it is probable he would not sacrifice the pleasure of bestowing that distinguished epithet on mine. However, as he judged my conjecture, I know not on what foundation, inconsistent with the principles of chemical science, I have mixed rust of iron with petrol, and afterwards with petrol to which sulphur was added, and found it disposed to coalesce in a few days.

P. 422. "One of Mr. Kirwan's objections to the deposition of materials at the bottom of the sea is thus stated:—'Frisi has remarked, in his mathematical discourses, that if any considerable mass of matter were accumulated in the interior of the ocean, the diurnal motion of the globe would be disturbed, and consequently it would be perceptible.' The appeal made here to Frisi is singularly unfortunate, as that philosopher demonstrated the contrary to Mr. Kirwan's position. The instance just given may serve as one of many to show what confidence is to be placed in that undigested mass of facts and quotations which Mr. Kirwan, without discrimination and without discussion, has brought together from all quarters." Mr. Playfair might, however, easily infer, from the loose manner in which Frisi is quoted, (namely, in *some* of his mathematical treatises, so different from my usual manner, in which the page I take from is mentioned,) that I had not that author before me; and, in fact, I took it from Mitterpacher's Physical Description of the Earth, p. 25, who says, that according to Frisi, in the case above mentioned, the velocity with which the centre of the globe would move would be increased; omitting the calculation, and the mention that the increased velocity would not be *sensible* for a long period of years. I hope therefore it is the only one out of the many quotations I have made in which any mistake can be found: if Mr. Playfair could find any other, he doubtless would have mentioned it. The attempt to weaken the force of the numerous facts I collected, adverse to the Huttonian theory, by calling them an *undigested* mass, is curious, and, if allowable, would furnish a very convenient and expeditious method of getting rid of

of them, but will not, I presume, appear perfectly satisfactory to an impartial public.

Page 427. The fact relative to the deltas formed in the mouth of the Bourampouter Mr. Playfair thinks I have misapprehended, because major Rennell does not assert that rivers employ *all* the materials which they carry with them, and deliver none into the sea. On the contrary, I think, they carry many of them into the sea, but not to any great distance, much less into its unfathomable depths, as Dr. Hutton asserts. The fact relative to the extension of coasts is now so well known to all modern geologists, that it were time lost to dwell longer on it: that the deltas themselves are diminished by particles detached from them, and carried into the recesses of the deep, is a remark which I do not recollect to have met with; but in some instances, where they consist merely of sand, they are often diminished by the winds: that even the argillaceous particles are not carried far into the sea, may be seen in Morse's American Geography, p. 49, Irish edition.

I decline entering into any further discussion of Mr. Playfair's replies to some other objection made by me to the Huttonian theory. The intelligent reader will meet with many confident and arrogant assertions of which he probably will require some proof, as in p. 481 and 482; many that are perfectly unsatisfactory or even contradictory, as where he allows that the impulsive motion of the waves against the shores is greater at a *small* distance from them, and yet asserts that the *detrites* of the shores are conveyed to a *great* distance. He also affirms with great confidence, that as the flowing of the tide requires just six hours, and the ebbing of it also six hours, the quantity of matter moved, and its velocity, must be just the same: p. 432. In the abstract this is certainly true, and in the middle of the ocean; but in most harbours the contrary happens: thus La Lande tells us that in the harbours of Brest, Dunkirk, Bordeaux, and Rouen, the ebb tide is about a quarter and often half of an hour slower than the flow: vol. iv. p. 117. These exceptions, I am persuaded, he is well acquainted with; but his *hurry and impatience* * (if I may be permitted to use his own expressions) to combat my assertions led him to overlook them. He is much at a loss to account for the remains of elephants and of the rhinoceros found in Siberia, and thinks it most probable that they belonged to antient species of those ani-

* These are the causes to which he ascribes the many mistakes he supposes me to have committed in combating the Huttonian theory; to reason he thinks me incapable.

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mals that could endure the severity of a Siberian winter: p. 475. If I had advanced such an opinion, it is probable he would be equally at a loss to find an epithet sufficiently severe to stigmatize it.

P. 481. It is evident, he says, that my geological writings are the work of a man who has not seen nature with his own eyes. This, I suppose, he infers from the total absence of observations made by myself. It is however pretty notorious here, that I have visited, traversed, and examined, most of the numerous mountains in this country; but I thought that in a controversy of this nature, the testimonies of persons who had taken no part in it, and who had seen much more than I have, would be more effectual and convincing: it is much easier to vilify my writings than to answer them.

No absurdity appears to Mr. Playfair so great as the attempt to connect the Mosaic history of the creation of the earth with any philosophical inquiry concerning it: this attempt he thinks injurious both to the freedom of philosophical investigation and to the dignity of religion: p. 477. The text of Moses he thinks covered with a veil which cannot be torn off, and must be considered as if it never existed: p. 478. Yet in other parts of his work he seems himself sensible of the extravagance of this assertion taken in the most extensive sense, p. 126; he seems to limit it to the *age*, *figure*, and *motion* of the *earth*; which no geologist ever pretended to infer from the Mosaic text, in which no mention of them is to be found, no more than they have the explanation of the act of creation itself; a notion which he also unjustly ascribes to them: but the series of events which took place after the creation of the earth, are too plainly mentioned to be overlooked or misunderstood: to say that this account is so obscure as not to be intelligible, is tantamount to saying that it is useless. It was never pretended that Moses intended to write a treatise of geology, any more than that Greek or Latin historians intended to give a treatise of astronomy from their occasional mention of eclipses or comets; nor is the genuine philosophical investigation of those phænomena any more impeded in one case than in the other: on the contrary, due notice is taken of their accounts by all astronomers. But there is a species of investigation, abusively called *philosophical*, which abstracts from historical accounts either of the creation or of the flood, as if the accounts given of both by Moses were unworthy of credit: to this objection the Huttonian theory is certainly liable, though I

never charged it upon it: so far was I from wishing to make use of what Mr. Playfair called poisoned weapons, as he unjustly accuses me of having done.

It is in vain Mr. Playfair seeks to compare geology with astronomy and zoology; neither of these sciences requires any notice to be taken of the original constitution of their objects, their actual state being very nearly the same as their primordial state: but, where hybrid species occur, their origin never fails of being attended to.

In geology, the case is very different: here we meet with objects whose original state must have been very different from their actual state. Rocks or stones presenting regular forms must of necessity have been originally in a state from which such forms could arise. Masses now hardened into stone, but presenting the impressions either of vegetables or of other stones, must have been originally in a soft state. Calcareous stones filled with shells must have been originally in a state fitted for the admission of those shells; hence geologists necessarily recur to a state of inanimate nature prior to the present. This is admitted by Dr. Hutton as well as by Neptunists; but he thinks the present state to have originated from a gradual destruction of a former, as that did from a still more antient: still the most antient of these worlds either resembled the present, or it did not: if not, we can say nothing of it; if it did, the same difficulties must occur, and consequently its primordial state must have been different from its subsequent state, as this state is supposed to have been similar to the present. The crystallized or soft state of our present rocks Dr. Hutton thinks proceeded from an igneous fusion of the materials of a prior world: but he cannot suppose this of the first of these worlds; its similarity with ours must therefore be otherwise accounted for.

I shall here conclude my observations on Mr. Playfair's observations. Controversies managed as this has been by him and Dr. Hutton, whose favourite method of answering objections consists in depretiating or sneering at the understanding, and undermining the credit of their author, are a disgrace to philosophy, and sufficiently expose the weakness of the cause that obliges to have recourse to such expedients.

I am, &c. &c.

Mr. Tilloch. RICHARD KIRWAN.

II. *An Illuſtration and Confirmation of ſome Facts mentioned in an Eſſay on the primitive State of the Globe. By* RICHARD KIRWAN, *Eſq. LL.D. F.R.S. and P.R.I.A.*

THERE is a remarkable fact ſtated in this eſſay, with reſpect to which the Moſaic account is fully at iſſue with the moſt plauſible of the lately deviſed philoſophic theories of the primitive ſtate of the globe, namely, the emerſion of ſome portion of land from the primæval ocean previous to the creation of fiſh: Moſes expreſsly affirming, Buffon, the anonymous author of *L'Hiſtoire du Monde primitif*, and many others, expreſsly denying it. In proof of the Moſaic account, I alleged that no petrifactions were found imbedded and incorporated in maſſes of ſtone in ſuch countries as were elevated 8500 or 9000 feet above the actual level of the ſea—for inſtance, in the great Tartarian platform and the elevated regions of Siberia—though in all inferior regions of the ſame extent ſuch petrifactions were abundantly found, at leaſt in limeſtones; but even in theſe none were found in thoſe elevated tracts, as I proved by the teſtimonies of all the philoſophic travellers who have traverſed and examined them.

Bouguer and Don Ulloa* atteſt the ſame fact with reſpect to Quito and the lofty regions of South America, having met with none in ninety leagues from a little north of the equator to Cuenca, between 2° and 3° ſouth of it, Quito being elevated 9374 feet above the level of the ſea. I even doubted whether the petrifactions found by Mr. De Luc on mount Grenier, at the height of 7800 feet, were incorporated in the body of any ſtony maſs; but he has ſince aſſured me that they were: now the ſhells he found being *cornua ammonis*, a ſpecies of thoſe called *pelagicæ*, it would thence appear that the ſea had riſen ſtill higher, though not above 1000 feet.

To repel this proof of the Moſaic account, it has been replied by the laborious, learned, and eloquent writer of *L'Hiſtoire du Monde primitif*, and others, that the keen air exiſting in theſe elevated regions had long ago decompoſed and conſumed the ſhells that might have been there depoſited; but, as the ſtones ſtill remain, it is evident that the ſhells incorporated in their interior muſt alſo have remained, if any ſuch were ever contained in them.

However, it is inſiſted that petrified ſhells have been found at a far ſuperior height to that which I ſtated as the higheſt

* Bouguer, Figure de la Terre, p. 65. Don Ulloa, Mem. Philoſoph. vol. i. p. 303.

limit at which they could be found, namely 9000 feet, for that thoſe which I quoted as proofs of a ſubſequent deluge, found, according to Don Ulloa, at the height of 14,220 feet in Peru, were in reality petrified. To this account, as it was only a hearſay report of Gentil, who had it from Don Ulloa, I own I did not give full credit; at leaſt I thought the circumſtance of their having been petrified and imbodied in a rock not probable: ſince that time I have met with a work, compoſed by Don Ulloa himſelf, entitled *Mémoires Philoſophiques, Hiſtoriques et Phyſiques*, in the firſt volume of which, p. 34 and 364, the fact of the ſhells being petrified and imbodied in a rock is fully ſtated and confirmed: but I ſhall here ſatisfactorily prove that the height at which they were found did not exceed, nor even equal, 9000 feet above the level of the ſea; and, ſecondly, that they were left there by a deluge that ſucceeded the emerſion of land from the primæval ocean.

Firſt, Gentil tells us, *Mém. Par.* 1771, p. 439, in 8vo., that theſe ſhells were found on a mountain near Guancavelica, a ſmall town or village between 12° and 13° ſouth latitude, which mountain, he ſays, is far from being one of the higheſt of the Cordelieres; and that on the ſpot in which the ſhells were found, the mercury in the barometer ſtood at the height of 17 inches one line and $\frac{1}{4}$ = 17,103 inches; from which he infers that this ſpot was elevated 2200$\frac{1}{2}$ toiſes over the level of the ſea, = 13,869 Engliſh feet. This height I ſhall now ſhow to have been falſely eſtimated.

Don Ulloa tells us, p. 34 of the abovementioned work, and Gentil repeats after him, that, at the village of Guancavelica, near but ſomewhat below this ſpot, the mercury ſtood at the height of 18 inches one line and half. Now Bouguer, *Figure de la Terre*, p. 36, expreſsly ſays that Quito is elevated from 14 to 1500 toiſes only over the level of the ſea, and is the higheſt *inhabited* part of the globe: Guancavelica, therefore, which is inhabited, and muſt have been well known to Bouguer, cannot be ſo high as Quito. Quito was geometrically meaſured, Guancavelica was not.

Bouguer alſo tells us, *ibid.* in note, that the mercury at Quito ſtands at the height of twenty inches and one line: how then is it poſſible that it ſhould ſtand at eighteen inches and one line at Guancavelica, which muſt be much lower, if the barometer were not ill conſtructed? No difference of temperature between Quito and Guancavelica could cauſe ſuch an enormous difference as two inches in the mercurial height. The art and neceſſity of freeing barometers from air were not generally

generally known * before Mr. De Luc's immortal work on the modifications of the atmosphere, which was not published till upwards of thirty years after Don Ulloa's experiments. The air, then, remaining in his barometer, which he probably filled at Lima, in whose territory Guancavelica lies, under a pressure of 28 or between 27 and 28 (French) inches, must have considerably expanded and depressed the column of mercury under it when brought up a mountain of, perhaps, 7000 or 8000 feet high; and hence this mercurial column remained so low at Guancavelica as eighteen inches and one line.

That in these circumstances the air contained in the barometer might cause a difference of three inches or more between the height at which mercury purged of air would stand, appears by the experiments of Cassini, *Mem. Par.* 1740, *Sur la Méridienne de Paris*, p. 172; for he found that the mercury, freed from air by ebullition in the tube, stood four or five lines higher than in barometers filled without that precaution. Nay, cardinal Luynes found the difference betwixt such barometers to amount sometimes to fourteen lines; *Mém. Par.* 1768, p. 490, in 8vo. How great must it therefore be in barometers transported to greater heights than that at which they were filled?

Moreover, Don Ulloa expressly tells us that the mountain on which these shells were found was *every where habitable*, *Mem. Philosophiques*, p. 34 and 35; which it could not be, and would be expressly contradicted by Bouguer, if its height were 13,000 English feet over the surface of the sea. From all which I conclude that the height of the mercurial column, if the barometers had been properly constructed, would have been about 22 French inches, = 23,44 English; and, as the temperature was remarkably cold, this would indicate a height of about 8200 feet above the level of the sea.

But, secondly, let the height be what it may, it is certain that these shells were deposited there after the emersion of land from the primitive ocean, and consequently by a subsequent deluge; for Don Ulloa expressly tells us, that in the same rocks in which these shells are found, *petrified wood* is also found; *Mem. Philosophiques*, p. 372. This wood must have grown on dry land, and must have been floated when

* I say, not generally known, because, though Mr. Du Fay had shown the advantage of expelling air from the mercury in the tube, in *Mem. Par.* 1723, and Cassini had followed that method in measuring the heights of Puy de Dome and Mont d'Or in 1740, yet it was not generally adopted until Mr. De Luc had proved its necessity, and perfected the method of performing it, in 1772. See De Luc, i. p. 58.

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the ſhells were depoſited, ſince both are found in the ſame rocks. It muſt have been brought thither by a deluge, as no wood can at preſent grow there, as Don Ulloa alſo atteſts. The ſhells are for the moſt part bivalves, which geologiſts allow to form petrifactions of the moſt modern date.

Laſtly, La Peyrouſe mentions that he diſcovered marine ſhells on mount Perdu, the higheſt of the Pyrenees, at the height of nearly 10,000 feet. How he aſcertained the height is not mentioned: but that theſe ſhells were depoſited by the deluge is certain; for at the ſame height he found alſo the bones of land animals petrified. *Journal des Mines*, xxxvii. p. 59, 60, and 64.

III. *An Eſſay on the Colours obtained from the metallic Oxides, and fixed by Fuſion on different vitreous Bodies. By* Alexander Brogniart, *Director of the National Manufactory of Porcelain at Sevres, Engineer of Mines, &c.*

[Concluded from p. 348 of our laſt volume.]

A SMALL book, entitled *L'Origine de l'Art de la Peinture ſur Verre*, publiſhed at Paris in 1693, and the *Traité de l'Art de la Verrerie**, by Neri and Kunckel, ſeem to be the firſt works that contain a pretty complete deſcription of the art of painting on glaſs. Thoſe ſince publiſhed, even the large work of Leviel, which forms part of the arts and manufactures of the academy, and what is ſaid in the *Encyclopédie Methodique*, are merely compilations from the two preceding works.

It is very remarkable, that if the proceſſes deſcribed in theſe works were ſtrictly followed, as we did in regard to ſome, it would never be poſſible to form the colours for which they pretend to give recipes. They only put the able artiſt in the way, but he muſt always make amendments or additions. This was the caſe with C. Miraud, who has the care of preparing the colours at the manufactory of Sevres. He was obliged, rather from his own knowledge than the information contained in the above books, to make the colours employed for painting on glaſs.

The limits of a memoir will not allow me to enter into hiſtorical details reſpecting the art of painting on glaſs: a full hiſtory of it has been given in the work of Leviel above mentioned. The matters and fluxes which enter into the

* There is an Engliſh tranſlation of this work entitled *Neri's Art of Glaſs*.

compoſition of the colours employed on glaſs are, in general, the ſame as thoſe applied to porcelain. Neither of them differ but in their proportions; but there are a great number of enamel or porcelain colours which cannot be applied to glaſs, where they are deprived of the white ground which ſerves to give them relief. When ſeen by refraction, ſeveral of them entirely change their tone, and aſſume a dirty tint, which can be of no uſe: we ſhall make them known when we come to treat of colours in particular. Thoſe which can be employed on this body change ſometimes in baking, and acquire a great tranſparency. In general they are not beautiful; but, when placed between the light and the eye, they then ſeem to anſwer the only object that can be propoſed in painting on glaſs.

The baking plates of painted glaſs preſents more difficulties than might be ſuppoſed. Care muſt be taken not to diſfigure the piece, or alter the colours: all the works we have read recommend a bed of gypſum. This method has ſometimes ſucceeded; but the glaſs, for the moſt part, becomes white and full of cracks. It appears that glaſs too alkaline (and alkalies are the moſt common in white glaſs) ſuffers itſelf to be attacked warm by the ſulphuric acid of the ſulphate of lime. We were eaſily able to bake pieces of glaſs much larger than thoſe before painted, by placing them on very ſtraight plates of earth or of ſoft porcelain.

Of Colours in particular.

After collecting the general phænomena exhibited by each claſs of vitrifiable colours, conſidered in regard to the body on which they are applied, I muſt make known the moſt intereſting particular phænomena exhibited by each principal kind of colours employed on ſoft porcelain and glaſs in a porcelain furnace.

Of Reds, Purples, and Violets, made from Gold.

Carmine red is obtained by the purple precipitate of Caſſius: it is mixed with about ſix parts of its flux; and this mixture is employed directly, without being fuſed. It is then of a dirty violet, but by baking it acquires a beautiful red carmine colour: it is, however, exceedingly delicate; a little too much heat and carbonaceous vapours eaſily ſpoil it. On this account it is more beautiful when baked with charcoal than with wood.

This colour and the purple, which is very little different, as well as all the ſhades obtained from it, by mixing it with other colours, really change on all porcelain and in every hand.

hand. But it is the only one that changes on hard porcelain. Its place may be ſupplied by a roſe colour from iron which does not change; ſo that by ſuppreſſing the carmine made with gold, and ſubſtituting for it the roſe oxide of iron here alluded to, you may exhibit a palette compoſed of colours none of which change in a remarkable manner. This roſe-coloured oxide of iron has been long known; but it was not employed on enamel, becauſe on that ſubſtance it changes too much. As the painters on enamel, however, have become the painters on porcelain, they have preſerved their antient method.

It might be believed that, by firſt reducing to a vitreous matter the colour called *carmine* already mixed with its flux, it might be made to aſſume its laſt tint. But the heat neceſſary to fuſe this vitreous maſs deſtroys the red colour, as I have experienced. Beſides, it is remarked that, to obtain this colour very beautiful, it muſt be expoſed to the fire as few times as poſſible.

The carmine for ſoft porcelain is made with fulminating gold ſlowly decompoſed, and muriate of ſilver: no tin enters into it; which proves that the combination of the oxide of this metal with that of gold is not neceſſary to the exiſtence of the purple colour.

Violet is made alſo with purple oxide of gold. A greater quantity of lead in the flux is what gives it this colour, which is almoſt the ſame crude or baked.

Theſe three colours totally diſappear when expoſed to a great porcelain heat.

Carmine and purple have given us in glaſs tints only of a dirty violet. The violet, on the other hand, produces on glaſs a very beautiful effect, but it is liable to turn blue. I have not yet been able to diſcover the cauſe of this ſingular change, which I ſaw for the firſt time a few days ago.

Red, Roſe, and Brown Colours extracted from Iron.

Theſe colours are made from red oxide of iron prepared with nitric acid. Theſe oxides are further calcined by keeping them expoſed to the action of heat. If heated too much, they paſs to brown.

Their flux is compoſed of borax, ſand, and minium, in ſmall quantity.

Theſe oxides give roſe and red colours capable of ſupplying the place of the ſame colours made with oxide of gold. When properly employed on hard porcelain, they do not change at all. I have cauſed roſes to be painted with theſe colours, and found no difference between the baked flower and that

not baked, except what might be expected to result from the brilliancy given to colours by fusion.

These colours may be employed indiscriminately, either previously fused or not fused.

In a great heat they in part disappear, or produce a dull brick red ground, which is not agreeable.

The composition of them is the same both for soft porcelain and for glass. They do not change on the latter; but on soft porcelain they disappear almost entirely on the first exposure to heat, and to make any thing remain they must be employed very deep.

This singular effect must be ascribed to the presence of lead in the crust or glazing. I assured myself of this by a very simple experiment. I placed this colour on window glass, and, having exposed it to a strong baking, it did not change.

I covered several parts of it with minium; and again exposing it to the fire, the colour was totally removed in the places where the red oxide of lead had been applied.

By performing this operation on a larger scale in close vessels, a large quantity of oxygen gas was disengaged.

It appears to me that this observation clearly proves the action of oxidated lead on glass as a destroyer of colour: it is seen that it does not act, as was believed, by burning the combustible bodies, which might tarnish the glass, but by dissolving, discolouring, or volatilizing with it the oxide of iron, which might alter its transparency.

Yellows.

Yellows are colours which require a great deal of care in the fabrication on account of the lead which they contain, and which, approaching sometimes to the metallic state, produces on them black spots.

The yellows for hard and soft porcelain are the same: they are composed of the oxide of lead, white oxide of antimony, and sand.

Oxide of tin is sometimes mixed with them; and when it is required to have them livelier, and nearer the colour *du fouci*, red oxide of iron is added, the too great redness of which is dissipated in the previous fusion to which they are exposed by the action of the lead contained in this yellow. These colours when once made never change: they disappear, however, almost entirely when exposed to a porcelain heat.

These yellows cannot be applied to glass: they are too opake and dirty. That employed by the old painters on glass has, on the contrary, a beautiful transparency, is exceedingly brilliant, and of a colour which approaches near to that of gold. The processes which they gave clearly showed that silver

ſilver formed part of their compoſition; but, when exactly followed, nothing ſatisfactory was obtained. C. Miraud, whom I have already had occaſion to mention, has found means to make as beautiful paintings on glaſs as the antients, by employing muriate of ſilver, oxide of zinc, white argil, and yellow oxide of iron. Theſe colours are applied on glaſs merely pounded, and without a flux. The oxide of iron brings the yellow to that colour which it ought to have after baking, and contributes with the argil and oxide of zinc to decompoſe the muriate of ſilver without deoxidating the ſilver. After the baking, there remains a duſt which has not penetrated into the glaſs, and which is eaſily removed.

This yellow, when employed thicker, gives darker ſhades, and produces a ruſſet.

Blues.

It is well known that theſe are obtained from the oxide of cobalt. All chemiſts are acquainted with the preparation of them. Thoſe of Sevres, which are juſtly eſteemed for their beauty, are indebted for it only to the care employed in manufacturing them, and to the quality of the porcelain, which appears more proper for receiving them in proportion to the degree of heat it can bear.

I remarked reſpecting the oxide of cobalt a fact which is perhaps not known to chemiſts: it is volatile in a violent heat: it is to this property we muſt aſcribe the blueiſh tint always aſſumed by white in the neighbourhood of the blue. I have placed expreſsly on purpoſe, in the ſame caſe, a white piece cloſe to a blue one, and found that the ſide of the white piece next the blue became evidently blueiſh.

The blue of hard porcelain, deſtined for what is called the ground for a great heat (*les fonds au grand feu*), is fuſed with feld-ſpar; that of ſoft porcelain has for its flux ſilex, potaſh, and lead: it is not volatilized like the preceding, but the heat it experiences is very inferior to that of hard porcelain.

Theſe colours, when previouſly fuſed, do not change at all in the application.

Blues on glaſs exhibit the ſame phænomena as thoſe on ſoft porcelain.

Greens.

The greens employed in painting are made with green oxide of copper, or, ſometimes, with a mixture of yellow or blue. They muſt be previouſly fuſed with their flux, otherwiſe they will become black; but after this firſt fuſion they no longer change.

They cannot ſtand a ſtrong heat, as it would make them diſappear entirely. Green grounds for a ſtrong heat are compoſed with the oxides of cobalt and nickel, but a browniſh green only is obtained.

Blueiſh greens called *celeſtial blues*, which were formerly colours very much in vogue, can be applied only upon ſoft porcelain; on hard porcelain they conſtantly become ſcaly, becauſe potaſh enters into their compoſition.

Theſe greens cannot be applied on glaſs: they give a dirty colour. To obtain a green on glaſs, it is neceſſary to put yellow on one ſide, and blue, more or leſs pale, on the other. This colour may be made alſo by a mixture of blue with yellow oxide of iron. I hope to obtain from oxide of chrome a direct green colour. The trials I have made give me reaſon to hope for ſucceſs. Pure chromate of lead, which I applied to porcelain in a ſtrong heat, gave me a pretty beautiful green of great intenſity and very fixed.

Biſtres and Ruſſets.

Theſe are obtained by mixtures in different proportions of manganeſe, brown oxide of copper, and oxide of iron from ombre earth. They are alſo previouſly fuſed with their flux, ſo that they do not change in any manner on ſoft porcelain, as lead has not the ſame action on oxide of manganeſe as on that of iron, as I aſſured myſelf by an experiment ſimilar to that already mentioned.

This colour fades very ſpeedily on glaſs.

Ruſſet grounds in a great heat, known under the name of *tortoiſe-ſhell grounds*, are made in the ſame manner. Their flux is feld-ſpar: no titanium enters into their compoſition, though ſaid ſo in all printed works. Titanium was not known at the manufactory of Sevres when I arrived there. I treated this ſingular metal in various ways, and never obtained but grounds of a pale dirty yellow, and very variable in its tone.

Blacks.

Blacks are the colours moſt difficult to be obtained very beautiful. No metallic oxide gives alone a beautiful black. Manganeſe is that which approaches neareſt to it. Iron gives an opake, dull, cloudy black, which changes very eaſily to red: the colour-makers, therefore, to obtain a black which they could not hope for from the beſt theoriſt, have united ſeveral metallic oxides which ſeparately do not give black, and have obtained a very beautiful colour, which, however, is liable to become ſcaly and dull.

Theſe

Theſe oxides are thoſe of manganeſe, the brown oxides of copper, and a little of the oxide of cobalt. The gray is obtained by ſuppreſſing the copper, and increaſing the doſe of the flux.

The manufactory of Sevres is the only one which has hitherto produced beautiful blacks in a ſtrong heat. This is owing rather to the quality of its paſte than to any peculiar proceſſes, ſince it does not conceal them. It is by darkening the blue by the oxides of manganeſe and iron that they are able in that manufactory to obtain very brilliant blacks.

Having here made known the principles of the fabrication of each principal colour, it may be readily conceived that by mixing theſe colours together all the ſhades poſſible may be obtained. It is evident alſo that care in the preparation, choice in the raw materials, and a juſt proportion of doſes, muſt produce in the reſults differences very ſenſible to an eye accuſtomed to painting. A mere knowledge of the compoſition of the colours does not give the talent of executing them well.

In recapitulating the facts above mentioned, to preſent them under another general point of view, it is ſeen:

1ſt, That among colours generally employed on hard porcelain one only is ſuſceptible of changing, viz. carmine, and the tints into which it enters: that its place may be ſupplied by the reds of iron, and that no colour then changes.

I have preſented to the Inſtitute a head not baked, executed according to this method; and the painting of two roſes, that of the one baked, and that of the other not baked. It has been ſeen that there was no difference between them.

2d, That among the colours for ſoft porcelain and enamel, ſeveral change in a conſiderable degree. Theſe are principally the reds of gold and iron, the yellows, the greens, the browns. They have not been replaced by others, becauſe this kind of painting has been almoſt abandoned.

3d, That ſeveral of the colours on glaſs change alſo by acquiring complete tranſparency. Theſe in particular are the yellows and greens.

4th, That it is neither by calcining the colours in a higher degree, nor previouſly fuſing them, as ſuppoſed by ſome, that they are prevented from changing, ſince theſe means really alter the changing colours, and produce no effect on the reſt. The change which ſeveral colours experience on ſoft porcelain and on glaſs does not then depend on the nature of their compoſition, but rather on that of the body on which they are applied.

Consequently, by suppressing from the colours of hard porcelain the carmine of gold, which is not indispensably necessary, we shall have a series of colours which do not change, and which will be absolutely similar to those presented to the Institute in the year 6.

IV. *Memoir on Tubes rendered harmonious by Hydrogen Gas. Read before the Society of Physics and Natural History of Geneva, by* G. Delarive, *Ex-President of the Royal Society of Edinburgh, and Member of the Medical Colleges of London and Geneva* *.

In a former sitting, our learned colleague professor Pictet communicated to the society a series of researches on tubes rendered harmonious by means of hydrogen gas, and explained the different musical phænomena to which these tubes give birth. He pointed out the influence of the length of the tube; of its breadth, and of the place where the gas is burnt; and explained the nature of the sounds produced. In regard to the cause of the sound, he offered only conjectures: as his labour was not directed to that object, it is under this point of view that I have resumed it.

Professor Brugnatelli, in my opinion, is the first person who published the experiment; which I shall endeavour to explain. It had been invented by a German: I shall here give a view of the principal circumstances attending it.

If a current of inflamed hydrogen gas be introduced into a tube the substance of which is elastic and sonorous, such as glass, metal, dry wood, &c., this tube, after the interval of some seconds, will emit a harmonic sound: if it be open at both extremities, the sound will be strong and full. The experiment may, however, succeed with a tube closed hermetically at one end, provided its diameter be so large as to admit of a circulation of the atmospheric air in sufficient quantity to maintain the combustion of the gas. The conditions essentially necessary for this purpose are: 1st, That the substance of the tube be elastic, proper for producing an echo; that is to say, for reflecting the undulations which proceed from the sonorous point: a tube of paper or pasteboard will emit no sound. 2d, The flame must be produced by a current of hydrogen gas. An inflamed jet of the vapour of spirit of wine or ether, a lighted taper, &c. are incapable of making the tube emit any sound.

* From the *Journal de Physique*, Fructidor, an. 10.

Let

Let us now examine what takes place in this experiment. There must be a certain point, which may be called the *sonorous point*; it is at this point that the vibrations which communicate to the air an undulatory motion are produced. This point is the place of combustion; for by changing the position of that place the sounds may be varied, as M. Pictet proved by a series of experiments. This gentleman observed also in that point, by means of the smoke with which he filled the tube, a continual succession of vibrations. These vibrations give birth to undulations, which are propagated with a known and determined velocity, and, striking the sides of the tube, are reflected with the same velocity as that with which they reached them. When the distance of the sides of the tube is such that the reflections backwards and forwards are isochronous with the vibrations natural to the sonorous cause, the sound increases in intensity, and becomes musically appreciable. It appears also that the reflected undulations re-act on the primitive vibrations produced in the place of combustion, and render them harmonically regular with them; for a certain space of time is almost always necessary before the instrument has acquired a regular and full sound: the tone of the tube will be higher or lower according to the greater or less number of undulations which take place in a given time.

There is another essential fact to be observed in the experiment which we here examine: the temperature of the column of air is not the same throughout its whole length. At the sonorous point, that is to say, the place of combustion, the temperature is exceedingly high; it is such, that the extremity of the aperture of the glass through which the hydrogen gas issues is constantly in a state of incandescence: if an inflamed jet of the vapour of spirit of wine or ether be substituted for a current of hydrogen gas, the heat is visibly weaker. According to some experiments it appears probable also that the temperature of the chamber where the experiment is made, and the purity of the air in the chamber, may have some influence on the result.

The object of my researches was to discover the cause of these phænomena, and how, and by what means, these sonorous vibrations are produced. During the combustion of hydrogen gas, it is well known that there is a production of water, and this water appears under the form of vapours. The place of the combustion being at a high temperature, these vapours must acquire a large volume; but, coming immediately into contact with air less heated, their volume must be rapidly diminished. A vacuum therefore must be formed,

into which the air rushes to be repelled by the new vapours, that contract in their turn. Is it from this alternate motion, produced by the great expansion and subsequent contraction of the vapours, that the sonorous vibrations result * ?

Such were the conjectures which might be formed on the probable cause of this phænomenon, when I accidentally met with a fact which appeared to me to give them some weight.

I had a thermometer tube about a line in diameter, at the extremity of which a small bulb was blown. In this bulb was a drop of water, which I wished to expel: for this purpose I exposed the bulb several times to the flame of a spirit-of-wine lamp. I was agreeably surprised to hear the tube emit a harmonious sound.

To repeat this experiment with success, the tube employed must be from 1 to 2 or 3 lines in diameter: its length may be about from 3 to 4 or 5 inches: it must have blown at one of its extremities a bulb the diameter of which is about triple that of the tube. It is not necessary that it should be regular. It even appears that, if it were a little flatted, the sound emitted would be higher. Into this bulb introduce a little quantity of water or mercury, and then expose it to a strong heat: that of a common spirit-of-wine lamp will, in general, be sufficient; but the flame must be large and strong when the operation is performed with a large tube. After the bulb has been exposed for some moments to the heat, it will emit a sound. Tubes of a large diameter produce a sound lower

* It appears to me probable that the sound produced by the air which rushes into the vacuum is more intense than that which results from an expansive force. The dreadful noise occasioned by the detonation of bubbles of hydrogen gas and oxygen is well known, and yet the lightest objects which surround the vessel are not even agitated by it; whence we may conclude that this phænomenon is produced by the sudden vacuum resulting from the destruction of the gas. The detonation of an inflammable gas pistol is much stronger than that of the air-gun, though the effect is less considerable; probably because in the pistol a vacuum succeeds the first expansive force. Every body is acquainted with that children's plaything called the humming top. It consists of a hollow sphere with an aperture at the circumference, which being made to turn rapidly on its axis produces a very strong humming noise. What is the cause of this noise? The same, in my opinion, as that above mentioned: the centrifugal force expels the air from the sphere through its aperture; a kind of vacuum is formed in it, the exterior air continually tends to enter it, and is immediately repelled, and hence a series of sonorous oscillations.—The AUTHOR.

The effect here spoken of seems rather to arise from the velocity with which the edge or lip of the orifice meets the air; for the same sound may be produced by directing a stream of air against the lip when the top is stationary.—EDIT.

than others. The size of the bulb appears to me also to contribute towards the same effect. The sound will be permanent for some moments; it will then gradually decrease, and at length will entirely cease. By suffering the apparatus to cool, and taking care to make the liquid condensed along the sides of the tube to descend into the bulb, the experiment may be repeated as often as may be thought proper.

Such is the experiment by means of which, in my opinion, the phænomenon of the harmonious tubes may be explained in a satisfactory manner. Let us now examine what takes place in tubes with a bulb, and what are the essential conditions necessary to make them emit a sound, and let us endeavour to discover the cause of this sound. We shall then compare them with the tubes employed with hydrogen gas, and shall examine in what these two instruments resemble each other in the effects they produce, the differences they exhibit under the same relations, and the causes of these differences.

The essential conditions necessary to make tubes with a bulb resound are: 1st, That the vessel has a bulb: I was never able to excite sonorous vibrations in a tube simply closed at one of its extremities. 2d, This bulb must contain an evaporable liquid: water succeeds very well; but it is attended with the disadvantage of forming in the tube, when it passes from the state of vapour to the liquid state, a small drop which often obstructs it entirely, and, sometimes, falling on the heated part of the glass, occasions a rupture. Mercury is not attended with the same defect: I was never able to produce sounds with ether, spirit of wine, or concentrated sulphuric acid. The quantity of liquid contained in the bulb is not a matter of indifference; it must be as small as possible: if there be too much, the tube becomes filled with vapours, which completely expel the air from it, and, heating it every where in an uniform manner, it no longer emits any sound. The third essential condition is the application of a strong heat to the bulb while the rest of the tube remains cold; for, if there be not a very striking difference of temperature between the bulb and the tube, there will be no sonorous effect. In the last place, the presence of atmospheric air is indispensably necessary: if it be entirely expelled, no effect can be produced. In all the periods of the experiment it will be found that the vapour fills only a certain portion of the instrument, and that it always contains air. I made several trials to determine exactly the space occupied by the vapour at the moment when the sound is heard; and I have found that, in small tubes at least, this space is somewhat less than

than the volume of the bulb. To determine it, I ſhut with my finger the orifice of the tube: at the moment when it began to ſound, I immerſed the orifice in mercury, removed my finger, and left the apparatus to cool. The vapour became condenſed; and I could judge, by the quantity of mercury which the preſſure of the atmoſpheric air made to aſcend in the tube, the ſpace which the vapour had occupied.

Such are the four conditions eſſentially neceſſary for obtaining ſounds: a bulb at the extremity of the tube; the preſence of a very ſmall quantity of water or mercury in the bulb; the application of a ſtrong heat to the bulb while the reſt of the tube remains cold; and, in the laſt place, the ſimultaneous preſence in the apparatus of vapour and atmoſpheric air. It is not neceſſary to add, that the orifice of the tube muſt always be open. Let us now examine what may be the cauſe of the ſound. I wiſhed firſt to aſcertain whether any chemical decompoſition of the liquid employed took place. For this purpoſe I took a tube of ſuch a length that the liquid might be entirely condenſed in it. I weighed it carefully before I made the experiment: I then made it emit ſounds, and found, after producing this effect ſeveral times, that its weight had neither increaſed nor decreaſed; whence I concluded that caloric produces no chemical effect on the liquid, and that the latter merely undergoes ſucceſſive evaporation and condenſation. Is it to this evaporation, then, of the liquid, and its condenſation, that the ſounds ought to be aſcribed? At firſt I believed that this queſtion might be anſwered in the affirmative; but the following conſiderations made me change my opinion: I firſt obſerved that there might be a ſucceſſive evaporation and condenſation, without the tube emitting any ſound, on applying to the bulb a ſufficient heat, but leſs intenſe than that neceſſary for making the tube ſound. Secondly, in making the experiment with a drop of water, I conſtantly found that the moment when the apparatus began to enter into action was that when the whole of the water was evaporated, and, conſequently, when the heat acted on the vapour: if a ſingle atom of liquid remained in the bulb, the tube was mute. From this fact I conclude that the ſound is produced by the action of the caloric on the vapour, and the reaction of the latter on the atmoſpheric air. The following is the manner in which I conceive that this phænomenon takes place: The vapour contained in the bulb receives, by an addition of caloric conveyed to it from every part in a large quantity, an increaſe of volume and of elaſticity; it proceeds with force from the bulb to the tube, and expels the air contained in it; but this air and the ſides

of

of the tube take from it, at the moment of contact, a portion of the caloric, its volume decreaſes, at the ſame inſtant a vacuum takes place, and the air reſumes its primitive ſpace. A new addition of caloric reſtores to the vapour its whole elaſticity, a part of which it ſoon loſes in the ſame manner. This is a conſequence of the oſcillations of that nature which give to the air an undulatory movement. The undulations reflected by the ſides of the tube become ſonorous and appreciable when they are iſochronous with the oſcillations produced by the cauſe I have indicated. From ſome tubes it is impoſſible to produce any ſound: in theſe I am of opinion that the reflected undulations cannot harmonize with the primitive oſcillations, and that the one deſtroy the other. In tubes with bulbs, the ſound, after a certain time, becomes weaker, and at length ceaſes. This may be explained by the propagation of heat along the ſides. When the bulb is very warm, and the tube cold, the vapour which riſes from the bulb ſuddenly loſes a part of its volume, and the oſcillations thus produced are ſtrong and frequent; but when the tube has acquired a certain degree of heat, the vapour gradually decreaſes in volume by paſſing from a very hot temperature into a place leſs warm indeed, but which, however, has a ſufficient degree of heat to make the oſcillations, which become weaker and fainter, to ceaſe at length entirely. That ſuch is the cauſe of the ceſſation of the ſound may be proved by applying a ſtrong heat to the part of the tube already heated, maintaining at the ſame time the ſame degree of heat under the bulb: by theſe means the limits of the temperatures are again very abrupt, and the ſound will be reproduced in its full force. It may be readily conceived that the ſubſtance of the tube muſt be ſome matter a non-conductor of heat: glaſs, therefore, is preferable.

Let us now compare the apparatus of a tube having a bulb with thoſe tubes in which hydrogen gas is employed. In the latter we have every thing neceſſary for the production of ſound, a vapour very hot, and conſequently highly elaſtic; for, as already obſerved, the place of the combuſtion is at ſo high a temperature that the beak of the glaſs is conſtantly red. This hot and elaſtic vapour, at the moment of its production, is in contact with the cold air, which enters the tube at the bottom and iſſues at the top; its volume muſt then decreaſe a moment after it has touched that cold air: new hot vapours ſucceed the former, and contract in their turn. This alternate expanſion and contraction gives birth to the undulatory movement of the air, and ſonorous undulations.

We

We have already ſeen that an inflamed jet of ſpirit of wine or of ether cannot make the tube ſound. This is a new proof of what I have advanced, that to produce ſound there muſt be a great difference between the temperature of the vapour and that of the ſurrounding air. In this caſe there is a ſucceſſive formation and condenſation of vapour, for the water ſtreams along the ſides of the tube; but the place of combuſtion has a much inferior degree of heat to what it has when hydrogen gas is burnt, and conſequently the vapour produced has leſs heat as well as leſs elaſticity. This caſe is analogous to that already mentioned, when we ſaid that a ſucceſſive evaporation and condenſation of the liquid might be produced in a tube having a bulb, without any ſonorous effects, by expoſing the bulb to a certain degree of heat, but leſs intenſe than that neceſſary for making the tube emit a ſound. We ſhould not be ſurpriſed if leſs heat were produced by the combuſtion of ſpirit of wine, or ether, than by that of hydrogen gas, when it is conſidered that in the latter caſe all the caloric contained in this gas, and in the oxygen of the atmoſpheric air conſumed, becomes ſenſible heat, and unites itſelf entirely with the vapour produced. On the other hand, in the combuſtion of an inflammable ſubſtance, ſuch as ſpirit of wine, we have only the caloric of the oxygen conſumed, rendered ſenſible, and which is in a great meaſure abſorbed by the formation of carbonic acid gas, ſo that it is only the exceſs which joins the vapour. It is therefore not aſtoniſhing that we have not heat ſufficient to give to this vapour all the elaſticity neceſſary for the production of ſound: the preſence of the carbonic acid gas reſulting from the combuſtion may alſo be an obſtacle to the ſonorous vibrations.

In tubes employed with hydrogen gas, the ſound is much ſtronger than in thoſe having bulbs: beſides, in the former it is permanent, in the latter it continues only a few moments. The reaſon of this is as follows: In the apparatus with hydrogen gas the tube is open at both extremities, conſequently there is formed a current of freſh air, which enters at the bottom and iſſues at the top; this current of air ſweeping along with the hot and elaſtic vapours receives their impulſe, and, by taking from them a portion of caloric, diminiſhes their volume: we find here, therefore, the moſt eſſential condition for the production of an intenſe and permanent ſound, viz. a great difference between the temperature of the air and that of the vapour; and this difference always remains the ſame by the continual renovation of the air; but this does not take place in tubes with bulbs, and therefore the ſound they emit is weaker and of ſhorter duration.

From

From this principle, that the great difference between the temperature of the vapour and air is neceſſary for the production of ſound, it may be eaſily conceived that every thing which tends to augment the heat of the current of air, and to diminiſh that produced by the combuſtion of the gas, will tend alſo to weaken or even to annihilate the ſound of the tube: but theſe two circumſtances are united in a warm chamber filled with people: the current of air, inſtead of being cool, is hot, and the quantity of oxygen being there leſs, the heat produced will be of leſs ſtrength. It needs therefore excite no aſtoniſhment, that in ſuch chambers the experiment does not always ſucceed.

Brugnatelli produced ſounds in tubes merely by the combuſtion of phoſphorus. Some philoſophers, conceiving that the ſonorous effects were owing in a peculiar manner to the hydrogen gas, have been induced to infer the preſence of that ſubſtance in phoſphorus. From what has been ſaid, is it not more ſimple to explain this phænomenon by the production of the phoſphorous acid under the form of vapours, which receive a great degree of elaſticity from the caloric diſengaged during the combuſtion, and the volume of which is ſoon diminiſhed by the contact of the cold air? We find there the alternate expanſion and contraction neceſſary for communicating to the air the undulatory motion proper for producing ſounds.

Such are the few obſervations I have had an opportunity of making on harmonious tubes; I hope they will prove in ſome meaſure intereſting to thoſe particularly engaged with this branch of philoſophy, and that they will contribute towards making them pay attention to this curious fact hitherto neglected.

V. *On Painting.* *By Mr.* E. Dayes, *Painter.*

Essay V.

On Invention.

Then, bold Invention, all thy powers diffuſe,
Of all thy ſiſters thou the nobleſt muſe;
Thee ev'ry art, thee ev'ry grace inſpires,
Thee Phœbus fills with all his brighteſt fires.
Mason's Fresnoy.

We ſhould never forget that the value of every art ariſes from the degree of mental capacity requiſite to its production, and the degree of inſtruction or pleaſure reſulting therefrom. Hence

Hence invention is juſtly ranked as the firſt and moſt noble part of the art: by it we diſtinguiſh the philoſopher from the mere painter, for he whoſe powers are confined to imitation deſerves no better name.

Invention not only relates to the way in which the artiſt tells the ſtory, but, in a higher ſenſe, requires the aid of ſuch probable incidents as may contribute to its further illuſtration. Raphael, in his Paul at Lyſtra, has finely contrived to ſhow the miracle wrought, by making one of the ſpectators, full of wonder and aſtoniſhment, lifting up the drapery to examine the limbs that have acquired their proper ſhape. N. Pouſſin, to convey an idea of the ſize of Polyphemus, has placed him on the diſtant mountains, and, by interpoſing a great medium of air, has ſeparated him from the figures of the ſame ſize on the fore-ground, and thereby produced a gigantic effect that beggars all deſcription. Barry, in his picture of Elyſium, has repreſented ſpiritual beings conducting the earth, thereby indicating that the world is governed by a ſupreme intelligence *.

The laws that govern hiſtorical painting are not confined to it, but extend to every other ſpecies of compoſition: hence it becomes the moſt noble part of the art, and from which all the others are but as ſo many branches. It not only requires a thorough knowledge of the human figure, but its attire, with landſcape, architecture, &c.; ſo that we may juſtly term it the only univerſal part of the art.

Some men, who term themſelves artiſts, move in an orbit ſo confined that their motions are ſcarcely diſcernible without the aid of ſome ſtrong magnifier. Unfortunately for the arts, the trifler meets with the moſt ſucceſs; perhaps the higher parts of the art are not ſo immediately within the reach of the capacity of the common obſerver: like jewels, their intrinſic value is known but to few. Sir Joſhua juſtly obſerves, "that the loweſt ſtyle will be the moſt popular, as it falls within the compaſs of ignorance itſelf; and the vulgar will always be pleaſed with what is natural, in the confined and miſunderſtood ſenſe of the word." Wiſdom is rather an unprofitable commodity; for we too often find in life the

* The above is one of a ſeries of pictures preſerved in the great room of the Society of Arts in the Adelphi. In thoſe pictures the artiſt may be ſaid to have invented his ſubjects altogether, and has ſo connected them as to illuſtrate that great moral truth, "that the attainment of happineſs, individual as well as public, depends on the cultivation of the human faculties." They exhibit a fine ſyſtem of ethics, at the ſame time that they expreſs, in a moſt determined and maſterly way, the beauty and advantages of legiſlation.

moſt

moſt ignorant the moſt ſucceſsful, and the moſt ſucceſsful the moſt honoured.

The great artiſts of former times did not only practiſe hiſtory, but portrait, nay even landſcape, and often excelled in architecture: then it was that one good work was enough to inſure a man ſucceſs and fortune, while now twenty haſty ones will ſcarcely furniſh him bread. Little and poor ſpirits have formerly made them ſeparate ſtudies, and their inability diſqualified them from teaching on a more liberal and extenſive ſcale, and now the practice of many is inſignificant and contemptible.

Man loves himſelf, and of courſe is intereſted in whatever relates thereto: hence the great end of painting ſhould be, recording actions of great perſonal patience, ſufferance, or heroiſm; but, above all, embodying ſome important moral truth for the edification of mankind.

> Some lofty theme let judgment firſt ſupply,
> Supremely fraught with grace and majeſty;
> For fancy copious, free to ev'ry charm
> That lines can circumſcribe, or colours warm:
> Still happier if that artful theme diſpenſe
> A poignant moral and inſtructive ſenſe.
>
> MASON'S FRESNOY.

That part of painting termed the ornamental may pleaſe and delight; but he who in his works combines ſublimity with ſentiment, may be juſtly ſaid to have reached one of the higheſt points of human felicity, and does an honour to the ignorant by raiſing them from their own native inſignificance to rank with the higheſt order of earthly beings:

> The dulleſt genius cannot fail
> To find the moral of my tale:
> That the diſtinguiſh'd part of men,
> With compaſs, pencil, ſword, or pen,
> Should in life's viſit leave their name,
> In characters which may proclaim,
> That they with ardour ſtrove to raiſe
> At once their arts and country's praiſe. PRIOR.

In the choice of our ſubject we ſhould prefer thoſe beſt known, and, if poſſible, ſuch a one as may carry with it a general intereſt. As a poet, Milton was particularly happy in his Paradiſe Loſt; it is not the deſtruction of a city, or the conduct of a colony, but the fate of worlds, which involved the happineſs of mankind at large. The Greek and Roman hiſtory with their fables, alſo the hiſtory of our own nation, and the works of our beſt poets, furniſh infinite matter for ſtudy, as well as thoſe grand and ſublime ſubjects that occur in the Old and New Teſtament.

But in our choice from the above, or any other work, we are not bound, like cattle, to follow a leader; the subjects unhandled are endless; those in the Bible abound from the most simple pastoral to such as are in the highest degree sublime. Besides, by exerting a proper degree of independence we shall not only be left free to act, but thereby stand the greater chance to give our works the character of originality. What could be more mortifying than to have it said that the best part of our picture was pitifully stolen from another? This would render us like the poor animal when stripped of his borrowed clothes, in which he looked so formidable, when behold he proved a mere ass! Such a conduct cannot be justified by any example found in a great master, whatever proofs he had given of his powers of invention, and it would be equally unpardonable in an artist of less celebrity. Nothing can be so contemptible as that poorness of spirit that goes limping after another, crawling over objects like a slug, and leaving nothing but slime behind: he never can be great that does not greatly dare. The mind, acting from its own impulse, will energize with more vigour than it possibly could by seeing objects through the medium of another's feelings. He who imitates the manner of another debases himself, by giving his company to the servant when the mistress is ready to entertain him.

Prints and drawings are useful to please the eye or enrich our thoughts, or, by having them before us, to keep up the fervour of the mind while employed on similar works of our own: then it is we may catch a grace from a figure, a grand or beautiful cast of drapery, or a thought that may give energy or brilliancy to our own, and that without copying. Collections of good prints are highly valuable to the artist; they add a nobleness to his conceptions, and raise and warm his imagination: so do fine descriptions in history and poetry. The prints after Raphael, M. Angelo, and the Caracci, will afford a fund of entertainment and instruction; and fine instances of forms in the back-grounds of Titian and Paul Veronese will be found with occasional good composition. Rubens's prints by Bolswert will be highly worthy attention, as well as those after the most celebrated French and British artists.

We should be careful not to suffer our pursuits to be interrupted by vulgar opinions or prejudices, but pursue our studies full of the conviction, "that patience and perseverance will lead to perfection." Nothing can be more absurd than to imagine one person too lively for such a study, another too grave, or a third too sober or honest for a genius: the fact is, if we suffer the opinions of others to affect our choice or over-

power

power our reſolves, we reſign ourſelves up to the moſt ignominious ſlavery, by giving up the right of regulating our own lives. When we have arrived at this part of the art, we muſt place ſome confidence in our own ſkill, otherwiſe we ſhall be liable to perpetual embarraſſment from the various opinions of others; we ſhould reſt ſatisfied if our works do not violate any principle in nature or rule of art. He who is doubtful of his own abilities will derive little advantage from the remarks of others, and the reſult of his inquiry will produce a maſs of crude and independent hints, that cannot poſſibly be reconciled, or collected into one point. A proper confidence is neceſſary; he cannot hope to ſucceed, who, before he begins, doubts if his abilities be equal to the undertaking.

As it is the great end of art to ſtrike the imagination, when we have made choice of a ſubject that is lofty, grand, or beautiful, we muſt be careful that it does not ſuffer in our hands by the introduction of poor or mean thoughts, ugly, inſignificant, or common-place objects. Baſſan, whatever ſubject he choſe, repreſented it by the peaſants of his own country; which deprived it of every merit but ſuch as depended on colour and effect. How oppoſite the conduct of Raphael in the Cartoons! who, knowing how much was expected from thoſe who practiſed the great ſtyle, has infuſed all the nobleneſs he was maſter of into his apoſtles, notwithſtanding hiſtory furniſhes no authority for ſo doing. As we cannot make our hero talk greatly, we muſt make him appear capable of great actions, by adding all the externals of dignity and grandeur correſpondent to high ſentiment and great action; a power which all men wiſh, but few attain.

As it is in our power, ſo it is our duty, to produce that unity which nature does not always do. Thomſon has finely heightened the death of Amelia by the thunder-ſtorm. A murder perpetrated in a gloomy day, or at night, will affect our feelings more ſtrongly than in a broad flaring light.

Events become more compact, and of courſe more intereſting, by making the inanimate ſcenes of nature more dreadful or lovely, or by adding a more ſublime caſt to the human countenance.

Though many things in nature and art exceed expectation, yet nothing ſenſible has the power to exceed or even equal the capacity of thought: it is from this power of the mind the artiſt derives his advantage. Mountains may be imagined loftier or more pictureſque, lakes more extenſive and clear, rivers more rapid or ſlow, rocks more vaſt and wild,

caverns more gloomy, ruins more majeſtic, and the whole face of nature dreſſed in ſun or ſhade as beſt ſuits our purpoſe, while we may render the human figure more beautiful or grand.

The painter of hiſtory, like the hiſtorian, repreſents the *event, not the man*, which is the province of the portrait-painter and biographer.

The Dutch have treated hiſtory under circumſtances ſo purely local, that Chriſt has appeared in the ſtorm in a common fiſhing-boat with the tri-coloured flag flying; and Dalila cutting a lock from a huge black peruke of the end of the 17th century.

Two advantages reſult from going to remote hiſtory for our ſubjects: one is, it becomes more venerable; another is, that the inaccuracies of *coſtume* are not ſo eaſily perceived.

The two diviſions of hiſtory generally rank under the grand ſtyle, and what ſir Joſhua terms the ornamental, but which from its delighting in variety is better deſcribed by the word *picturesque*, which is oftener applied, and not of ſo debaſing a nature. The picturesque is founded on an union of the regular and irregular, the grand or ſimple, or the regular only: for inſtance, the arch of a bridge which is uniform is ſimple and grand, but being broken it becomes irregular or picturesque: decorations of ivy have a ſimilar effect. A head and body ſeen in front, with the hair flowing uniformly on each ſide, as we ſometimes ſee in the portraits of Georgione and Titian, is grand: incline the head, and vary the hair on one ſide, it changes its character to the picturesque. Similar groups, nay, even ſingle figures, perfectly alike, often characterize the higheſt ſimplicity of compoſition, as in ſome of Raphael's pictures, and of which there is a fine inſtance by Titian in the church of the Friars of St. Francis at Venice; an etching of which, by Le Febre, is in every one's hand. Pouſſin ſhowed it in his landſcapes, in his buildings, and in the ſtraight and parallel ſtems and uniform foliage of his trees. The picturesque, on the contrary, is ſeen in the contraſted groups of Rubens; the croſſing and winding of the ſtems, irregular foliage of trees, and in broken buildings; *but ever accompanied with a beautiful choice*; for, as before obſerved, if the picturesque was to be ſeparated from the beautiful: there would be nothing left worthy the dignity of painting.

The grand ſtyle requires the greateſt ſimplicity of conduct: the rejection of all things little is neceſſary to its completion, not only as to diſpoſition, form, the minutiæ of colour and effect, but to the total diſregard of all the trickery of penciling:

above

above all, if our ſubject is lofty, we muſt be careful not to admit any thought that is trifling or mean; a fault many of the old maſters are not entirely free from.

The drapery ſhould partake of the ſame great character: all the minute parts muſt be rejected, the folds ſhould be broad and ſimple, poſſeſs an eaſy communication, and gracefully follow each other as by chance.

The application of thoſe ſtyles muſt depend on the nature of the ſubject all together; the choice of the Roman ſchool required a ſimplicity of conduct which muſt neceſſarily run through the whole picture. The ſubjects of the Cartons would ſuffer by a deſtruction of the unity, from changing the character of any part: the unaffected compoſition, ſolemnity of colour, the broad and ſimple folds of the drapery, form a whole that would be deſtroyed by attaching ſhowy colour, or changing the character of the compoſition or drapery to the picturesque. But ſportive ſcenes, feaſts, proceſſions, and marriage ceremonies, ſuch as were principally choſen by the Venetians, perfectly agree with that picturesque effect ariſing from ſplendour of colour, oppoſition of light and ſhade, contraſt, and variety of draperies.

This character appears to ariſe (as before obſerved) out of the very nature of the ſubject. Who that wiſhed to repreſent an aſſaſſination would introduce ſplendid colours, or great vivacity of light? On the contrary, would he not rather uſe ſad and ſolemn ones, with darkneſs, obſcurity, and great depth?

What has reduced the Venetian ſchool is want of expreſſion. Paul Veroneſe, in his picture of Mary Magdalen anointing the feet of Jeſus, has made it a mere eating-match of Venetian ſenators; and Tintoret, in his Marriage at Cana, has made the company ſcarcely notice the miracle of turning the water into wine.

True hiſtory ſhould never have its gravity diſturbed by any improbable or impoſſible circumſtance. What can be more abſurd than Raphael's flying apoſtles in the Attila, the angels in the battle of Conſtantine, or St. Cecilia in the ſame picture with St. Paul, St. John, St. Auguſtin, and Mary Magdalen? The ſame artiſt in the School of Athens has confounded all the circumſtances of time and place. How unlike is the conduct of a great modern artiſt, who, in bringing together a number of great characters that lived at remote periods from each other, has wiſely placed them in Elyſium? In the picture by Titian, in the church of St. Francis in Venice (formerly alluded to), we find the Virgin

and Child, St. Peter, St. Francis, and Venetian ſenators, to the entire deſtruction of chronology.

Thoſe who chooſe to exert their fancy had better invent their ſubject altogether, and not falſify a fact by going to true hiſtory, where invention can never juſtify the introduction of allegoric fiction. It detracts from the merit of Conſtantine as a conqueror, by bringing the hoſt of heaven to his aid: without it we may ſuppoſe he could not have overcome his more powerful partner in the empire. But the higheſt joke is to find Heliodorus plundering the temple of Jeruſalem (as related in the ſecond book of Maccabees), and pope Julius preſent as a ſpectator.

> I loſe my patience, and I own it too,
> When works are cenſur'd not as bad, but new;
> While, if our elders break all reaſon's laws,
> Theſe fools demand not pardon, but applauſe. POPE.

Without racking our invention for fables above the comprehenſion of the vulgar, there are many fine moral ſtories for the practice of thoſe who can afford the time and expenſe neceſſary to their completion; ſuch as the patient reſignation of that firſt of mortal men, Socrates, at his death; Curtius leaping into the gulf; the Decii devoting themſelves for their country; the ſudden reverſe of fortune in Marius at the ruins of Carthage; the folly of Candaules in expoſing his wife's beauty to his friend Gyges; the deſire of fame in Cæſar weeping before the ſtatue of Alexander; the virtue of Phocion in refuſing the bribes of Alexander; and the piety of Æneas in preſerving his father from the flames of Troy; with numberleſs others that muſt occur to every one's recollection.

The Florentine and Roman ſchools have ſeized on the moſt prominent parts of the arts, and, having perfected them, left but little to do for thoſe who followed beyond embelliſhing: whatever was ſtrong and forcible they ſeized in their mighty graſp; hence thoſe who have ſucceeded them as they poliſhed have loſt vigour and expreſſion. The Caracci attempted it, and with ſome of their ſcholars were often ſucceſsful, and for dignity and expreſſion ranked next after the above great ſchools. The Venetians appear ſcarcely to have thought of it in the rich buſtle of their pictures. Rubens among the Flemings ranks firſt: and when the Dutch attempted at expreſſion it was always low and vulgar; Rembrandt was ſuch, with a deſperate bad choice of figure. Raphael for expreſſion juſtly ranks before any other painter, of which there are fine examples at hand in the Cartons at Windſor

Windſor caſtle, and which by the firſt judges are ranked among the beſt of his works, if not the very beſt. They are unqueſtionably preferable to any of his pictures in the Vatican, for purity of invention and hiſtoric truth. His eaſel pictures are generally poor.

By expreſſion we do not confine ourſelves to the face merely, but to the juſtneſs of the general action. That expreſſion is juſtly placed at the head of the art is evident from its difficulty, for to expreſs well we muſt in ourſelves feel the paſſion we with to repreſent. He who wiſhes to wring another's heart with anguiſh muſt feel as exquiſitely himſelf: hence the neceſſity of recurring to nature, and not depending on the feelings of another, as the manneriſt ever muſt. We ſhall obtain but little advantage in this inſtance from a model: we muſt therefore recur to ourſelves; and in ſo doing the looking-glaſs will become our beſt friend: for, as Pope obſerves,

They beſt ſhall paint them who can feel them moſt.

The paſſions, as they are called, by Le Brun are overcharged, ſo much ſo as to have become caricatures. There is no laying down rules for what muſt ever depend on the feelings. Next to nature, the antique heads of the Laocoon, the dying Alexander, the Niobes, and many others, will be well worth conſulting: but expreſſion muſt be general; we ſee agony in the fingers and toes of the Laocoon as ſtrong as in the face. Domenichino and Pouſſin were great in expreſſion; but, as before obſerved, Raphael is the firſt modern.

It would be an unpardonable neglect to overlook a work of Britiſh art, that for expreſſion would diſpute precedence with the beſt of the Roman ſchool. Where ſhall we ſee paternal deſpair repreſented with more force and truth than in ſir Joſhua Reynolds's count Ugolino, or the horrors of death pronounced in a more determined and maſterly manner than in the children? We need ſay no more: Sweetneſs and Truth were his handmaids; and when he died the Graces would no longer remain on the earth. Where encouragement has been offered, the Britiſh artiſts have done their duty: in portrait and landſcape they equal, if not exceed, the beſt; and in hiſtory ſome works have appeared honourable in the higheſt degree to the nation. They will be ſufficient to ſhow to poſterity the powers of the art in the time we live: a few good works are enough, perhaps, in an ungrateful age *.

If

* I am juſtified in uſing the words ungrateful age, by the ſhameful neglect ſhown at the ſale of Macklin's pictures by Britiſh artiſts. Art,

If we wiſh to know much, we muſt ſee many things of a kind, that by comparing them we may acquire a more perfect idea of the thing than the real object conveys; and thoſe ideas we are bound to improve till we underſtand the true principles of general nature, or unaccompanied with thoſe peculiarities that mark the defects of the individuals in each ſpecies.

When we have determined on a ſubject, we muſt with all due expedition make a ſketch of the principal perſons concerned in the event, or whatever conſtitutes the feature of the picture, without regard to dreſs or any of the leſſer incidents, as much of the fire and ſpirit of the actions, as well as the grandeur of the whole, depends on the firſt impreſſion. We muſt then do by our ſketch as Virgil ſaid he did by his works, "lick them into ſhape;" for, as the firſt part depends on the imagination, ſo the ſecond is the reſult of judgment: we are then to prune or add till the whole comes into perfect ordonnance, chooſing ſuch objects as are ſtrikingly noble or beautiful, and adding ſuch acceſſory circumſtances as may beſt contribute to illuſtrate the ſtory. In our progreſs with the ſketch we may add a ſecond or third group, ſettle the dreſſes and the back-ground, whether landſcape or architecture, the diſpoſition of the maſſes, and complete the whole by ſlightly tinting it.

We are bound to preſerve a whole throughout our work, as well as an unity of time and place: we ſhould therefore avoid every thing local; even a well-known face or figure deſtroys intereſt, by rendering the work familiar.

Laireſſe whimſically deſcribes a picture of the deluge, painted by an artiſt of his time, as made up of abſurdities. Among other things jumbled together is "the grave of Mahomet, rolls of Virginia tobacco, a cardinal's cap, a child in a goecart, pickled herrings, a ſmutch-pot and pencils, all the toys from a Nuremberg toy-ſhop, the records of the imperial chamber at Spire," and, to crown the whole, "the Vatican," and the artiſt's own dear ſelf "ſitting on the fore-ground ſketching every thing after the life." The man muſt be ignorant indeed who could be guilty of

like beauty, having once withered, can never be reſtored. Conſtantine, with all his wealth and power, could not reſuſcitate it, but was obliged to reb antient Rome to adorn his new city. Rouſe, countrymen, rouſe! you will add to your own immortality, and give vigour to the labours of the artiſt, by encouraging the noble walk of hiſtory painting. How renowned have the popes Julius and Leo, with the Medici, become from ſo doing! The preſent opportunity loſt may never be regained. Why ſhould we not contend for the empire of wiſdom as well as of the ſea?

ſuch

ſuch groſs errors. An artiſt poſſeſſing common ſenſe will never act ſo abſurdly as to mix in the ſame picture things antique and modern; an error common among the Venetian, Flemiſh, and Dutch maſters.

If the ſubject we mean to handle lies in Egypt, Athens, or Rome, let us endeavour to tranſport ourſelves thither by the warmth and activity of our imagination, and, by removing every thing local, lead the ſpectator through the delightful and magical mazes of ſcience, ſo that he may actually imagine the ſcene tranſacting before his eyes.

VI. *Extract of a Memoir on Argental Mercury. Read before the French National Inſtitute, by* C. CORDIER, *Engineer of Mines* *.

THE mineral called formerly native amalgam of ſilver, and which ſince the labours of C. Haüy is now known under the name of *argental mercury*, is one of thoſe natural metallic combinations, the mineralogical and chemical properties of which had been the leaſt perfectly deſcribed and examined. It is however probable that an accurate knowledge of this ſpecies would have been obtained, had not its great rarity prevented chemiſts from ſacrificing the only ſpecimens of it which they poſſeſſed in order to ſubject them to complete examination. The places where argental mercury is found are the mines of Roſenar in Hungary, thoſe of Morſfeldt in the ci-devant Palatinate, now the department of Mont-Tonnerre, and particularly thoſe of Muſchel-Landſberg in the ſame country: theſe are the only mines by which it has been hitherto furniſhed.

Though this mineral is at preſent too rare to be the object of the labours of the miner, it will be ſeen that it deſerves the attention of the mineralogiſt, and to make a figure among the moſt remarkable of the metallic ſpecies.

Argental mercury is found always diſſeminated throughout the maſs of the veins, ſometimes in very thin leaves which fill up the fiſſures, ſometimes in ſmall cryſtals totally engaged in the matrix, or entirely inſulated in the cavities.

This mineral ſubſtance has the colour and reſplendence of ſilver or poliſhed tin, or rather more frequently of liquid mercury, becauſe it almoſt always retains at its ſurface a thin ſtratum of the laſt mentioned metal.

Its regular forms are the dodecaedral-rhomboidal, and all its modifications.

* From the *Journal des Mines*, No. 67.

The

The ſmall lamellæform leaves of argental mercury are for the moſt part bent, and follow the undulations of the rock to which they are applied. Their ſurface is generally ſmooth and poliſhed, but much leſs than that of its cryſtals. This metal is eaſily ſcratched by a piece of ſharp-pointed ſteel. By ſcraping it loſes almoſt all its ſplendour, and becomes dull. When rubbed on copper it leaves a white metallic trace. It is brittle and eaſily broken: its conſiſtence approaches to that of martial pyrites. Its fracture is conchoid, and exhibits no appearance of laminæ. The fragments of it are indetermined, with very obtuſe edges.

Its ſpecific gravity, determined from a mean of ſeveral experiments, is 14·1192; argental mercury therefore, next to platina and gold, is the heavieſt of bodies. When this mineral is heated at the blow-pipe, the mercury becomes volatilized, and a ſmall button of ſilver may be eaſily obtained.

The varieties of the regular forms are, 1ſt, The perfect rhomboidal dodecaedron (fig. 1. Plate III). The incidence of the two contiguous faces is 120°. The cryſtals not being ſuſceptible of any mechanical diviſion, it is not poſſible to know preciſely whether this ſolid be the primitive form of argental mercury, as is probable, and as we ſhall ſuppoſe it to be, in order to have the expreſſion of the laws of decrement and the value of the angles. This ſuppoſition can produce no error, becauſe the reſults of the calculation may be eaſily transferred, ſo as to apply them to the octaedron, the tetraedron, or the cube, which are the only other forms poſſible.

2d, The dodecaedron truncated on the ſix ſolid angles compoſed of four planes. The ſix new faces are produced in virtue of a decrement by one row: they belong to the cube, and make with the faces of the primitive form angles of 135°. According to the ingenious method of C. Haüy, the abridged expreſſion of the laws of decrement which produce this form is $P\,\overset{\prime}{\overset{\prime}{E}}$.

3d, The ſame as the preceding, the place of each ridge of which is ſupplied by a facet making an angle of 150° with the adjacent primitive face: theſe new facets take place by the ſubtraction of a row of moleculæ on all the edges. Its expreſſion is $P\,\overset{\prime}{B}\,\overset{\prime}{\overset{\prime}{E}}$.

4th, The dodecaedron truncated on all the ridges and all the ſolid angles, and having new facets on the edges of the truncatures which take place on the edges, and the ſolid angles compoſed of four planes. This form, which had not been

been before obſerved, is the moſt complex of all thoſe exhibited by mineral ſubſtances. It is produced by the interſection of the faces which belong to the following ſix kinds of regular or ſymmetric ſolids, viz. the cube, the octaedron, the rhomboidal dodecaedron, the ſolid with 24 trapezoidal facets, the ſolid with 24 iſoſceles triangular facets, and the ſolid with 48 ſcalene triangular facets. The complete cryſtal is terminated by 122 faces. The expreſſion of this form, repreſented fig. 2, is $P^{1}\,B^{2}\,\breve{B}^{1}\,A^{1}\,E^{1}\,E^{3}$.

The incidence of the faces of the primitive form with thoſe of the octaedron is 125° 15′ 52″; with thoſe of the ſolid having 24 triangular facets is 153° 28′ 4″; with thoſe of the ſolid having 48 faces 16° 53′ 36″.

Hitherto no complete anatomy of argental mercury has been publiſhed; mineralogiſts were ſatisfied with acquiring an approximate knowledge of its compoſition from ſimple experiments: it was therefore of importance to determine with accuracy the elementary principles of this mineral, and to fix the proportions. This analyſis was attended with no kind of difficulty *.

Sixty parts of this mineral were expoſed in a crucible to the action of a low heat, which was ſucceſſively increaſed, and continued as long as was neceſſary to volatilize all the mercury. The cryſtals, without ſuffering any ſenſible loſs of volume, were changed into ſpongy maſſes, which towards the end of the operation ſunk down and united into a metallic button: the weight of this button was found to be 16·5 parts, from which it was concluded that the weight of the mercury volatilized was 43·5.

This button was perfectly malleable, and had all the appearances of the pureſt ſilver. To aſcertain its purity it was expoſed to the action of nitric acid proved by nitrate of ſilver. The ſolution was effected without any reſiduum.

Oxygenated muriatic acid was poured into the ſolution, and the precipitate of muriate of ſilver was collected on the filter. The liquor tried by carbonate of potaſh furniſhed no precipitate: the ſilver then contained no foreign metallic ſubſtance.

In regard to the ſtate of the mercury in its combination, it is certainly not neceſſary to prove that it exiſts in a ſolid ſtate. To be convinced of it, nothing will be neceſſary but

* The cryſtals ſubjected to analyſis were covered with a ſtratum of liquid mercury, which was removed by preſſing them between the fingers in ſoft wax.

to conſider, firſt, that it forms almoſt three fourths of the whole maſs; in the next place, that the ſpecific denſity of the natural combination not only ſurpaſſes, by a great deal, the mean ſpecific denſity of ſilver and liquid mercury, but alſo that it is much more conſiderable than that of the latter metal, which is the heavier of the two. The ſpecific gravity indeed of the combination, calculated according to the formula of C. Haüy, would be only 12·5448, ſuppoſing the mercury liquid, whereas it is 14·1192; that of the mercury is only 13·5681.

A hundred parts of argental mercury, ſolid and cryſtalliſed, contain then of ſolid mercury - -	72·5
Silver - - - - - - - -	27·5
	100

Two other trials, made indeed with quantities leſs conſiderable, gave abſolutely the ſame proportions.

The identity of the reſults of the analyſis of this mineral, its peculiar ſpecific gravity, its faculty of cryſtallizing, its conſiſtence, and all the other mineralogical characters belonging to it, evidently prove that it ought to be conſidered as a real chemical combination, poſſeſſing fixed and invariable proportions, and that it is with propriety that a particular ſpecies has been formed of it in the mineralogical nomenclature.

It may be of utility to remark here how improper the denomination of native amalgam was to denote this mineral ſubſtance. The name ſtill employed in chemiſtry and the arts does not denote a ſolid combination, but a paſte-like mixture, compoſed of exceedingly ſmall cryſtals of argental mercury, adhering to each other by the medium of a certain quantity of liquid mercury. The conſiſtence of the maſſes of artificial amalgam is even very variable: it may be increaſed or diminiſhed at pleaſure, ſometimes by adding mercury, ſometimes by taking away a part of this metal, interpoſed by means of a proper filter, ſuch as a piece of ſhammoy leather. It is the difficulty, perhaps, of ſeparating entirely the exceſs of mercury in the ſolid combination that has occaſioned a belief that ſilver and mercury may be combined in all proportions: this opinion ſeems to be as unfounded as that in conſequence of which argil, rendered ductile by the means of water, was conſidered as a real combination, the proportions of which might be indefinitely varied. It is proper to add, that at the common temperature argental mercury is always perfectly ſolid, and beſides that

that it is insoluble in liquid mercury: this has been ascertained by experiment.

An exact knowledge of the specific density of argental mercury, as well as of the proportions of its two component principles, has suggested the idea of making some researches in regard to the density of solid mercury. Chemists have set out with the supposition that the moleculæ of the two metals experience no dilatation nor penetration in combining: knowing the specific gravity of silver = 10·4743, that of argental mercury = 14·1192, and the ratio of the two metals $\frac{2}{11}$, it will be found that the specific gravity of solid mercury ought to be 16·2662. In the case of there being a penetration of moleculæ, as is probable, the real density would be somewhat less: on the other hand, if there be dilatation, it will be found to be more considerable. In a word, this approximative result ought the less to be neglected, as it is probable that it will be always very difficult to attain *directly* to an estimation perfectly exact.

VII. *Extract of a Notice, read in the French National Institute, on a new Variety of Epidote.* By CHAMPEAUX *and* CRESSAC, *Engineers of Mines* *.

THE substance which forms the object of this notice was found in the primitive chain which traverses the country of the Grisons, and unites the mountains of St. Gothard to those of the Tyrol.

It has always been found united to a variety of red garnet, which Saussure has described † as a particular species under the name of *hyacinth de Diffentis*. To complete the description of this species, he gives a short description of the substance which forms the subject of this article, and he gives it the name of *phrenite*, because he thought he could distinguish in it characters which brought it near to the phrenite of Oisans.

In this description we shall follow the method adopted by professor Haüy.

Essential Character.

Divisible in a direction parallel to the planes of a right rhomboidal prism, which form with each other angles of 114° 37′ and 65° 23′.

* From the *Journal des Mines*, No. 67.

† Voyage dans les Alpes, § 1902.

Physical

Phyſical Characters.

Specific gravity 3·3739. This character was proved on the pureſt fragments that could be procured.

Hardneſs. It eaſily ſcratches glaſs; it is with difficulty ſcratched by quartz; ſtrikes fire with ſteel.

Tranſparency. Pellucid on the edges.

Colour. Bright gray.

Electricity. None by heat; acquires none by long continued friction.

Geometric Characters.

Primitive form. A right priſm with rhombal baſes; inclination of the planes M and T of the priſm (fig. 3, Plate III.) 114° 37′ and 65° 23′. The diviſions parallel to the planes are generally very cloſe; the laminæ are ſeldom obſerved in the direction of the baſes.

Structure. Very ſenſibly lamellar: the natural joinings ſeem to be ſomewhat cloſer in one direction than in another.

Fracture. Conchoid, ſhining, with ſmall cavities: it takes place only in one direction, that of the baſes; in that of the planes of the priſm nothing is obtained but laminæ, which manifeſt the ſtructure.

Chemical Characters.

With the blow-pipe. On the firſt application of heat the colour becomes leſs dark; the angles and the ridges then fuſe into a yellowiſh enamel, which grows brown in a continued heat, and is converted into ſcoria: if a thin plate be ſubjected to experiment, it becomes corneous before it is ſcorified.

Acids, cold. Acids have no action on it.

It reſults from this examination, and particularly the conſideration of the eſſential character, that the ſubſtance in queſtion belongs to the epidote; for it can be divided in a direction parallel to the planes of a right rhomboidal priſm, which form with each other angles of 114° 37′ and 65° 23′. It ſometimes happens that there is obſerved above the planes of the priſm facets oblique to the axes, which might give reaſon to ſuppoſe that they are parallel to the baſes, and thence be led into an error reſpecting the determination of the primitive form; but an attentive examination ſhows that they belong to other cryſtals which penetrate the former; and beſides, the examination of a form, ſufficiently prominent to admit of applying to it the laws of ſtructure, has proved that obſervation agrees with calculation.

This

This form, which has not yet been described among the known varieties of the epidote, results:

1st, From a decrement by one row on the edges G of the prism (fig. 3.) corresponding to the acute angles of the base.

2d, From a mixt decrement on the left, by four rows in breadth and three in height, on the other edges H.

3d, From a decrement by three rows to the left on the same edges. This is that which constitutes the new variety.

The preceding laws do not mark entirely the planes M and T.

4th, In the last place, from a decrement by one row on the acute angles E of the rhombus of the base. The latter reaching its limits, makes the face P disappear entirely.

It follows from this structure that the characteristic sign of the crystal will be $\overset{1}{G}\overset{1}{M}\ \overset{4}{H}\overset{3}{H}\ T\overset{1}{E}$; and the form produced being a prism of ten planes and diedral summits (fig. 4.), we may thence deduce the denomination of quadridecimal, which will express the four faces of the summits and the ten of the prism.

Calculation has given for the inclination of the face x produced on the adjacent plane M 163° 23′, and on the declining plane T 131° 17′; results which are agreeable to those obtained by geometry.

Independently of the form already described there have been observed also secondary crystals presenting at their surface parallel striæ. This, no doubt, is that described by Saussure in the following words: *striæ, as if in the form of bastions.* In a word, we may mention as pseudomorphic the forms of emarginated garnet, to which this epidote of Dissentis has been associated; for sometimes it covers it entirely by being moulded over it, and sometimes it is completely covered by it in such a manner, that one of the two substances cannot be seen but by the fracture of the other.

The observation of this new variety proves that the determination of mineral substances merely by their exterior characters is exceedingly defective; for the latter by its faces is very distinct from the species to which it belongs, but the geometric characters assign to it in the methodical system its real place.

We shall remark also that the epidote is a substance the varieties of which differ from each other according to the countries where they have been found: to be convinced of this, nothing will be necessary but to compare that of Dauphiny with that of Arendal and that of Dissentis. Their

aspect

aſpect is ſo peculiar that nothing can prove their identity but analyſis and the laws of ſtructure.

We ſhall compare this new variety of the epidote only with the phrenite, becauſe it is under this name that it is deſcribed by Sauſſure: it differs from it by its ſpecific gravity in the ratio of 33 to 36, and by its ſtructure, as it exhibits evident ſections in two directions, while the phrenite exhibits only one: in a word, it is not electric by heat.

The rock which accompanies it is compoſed of the ſubſtance of the garnet, the epidote itſelf, calcareous ſtone, and quartz. Theſe elements ſometimes are in proportions nearly equal; but it happens for the moſt part that the matter of the garnet predominates. In ſome ſpecimens the epidote is diſpoſed in thin zones between cryſtals of garnet, on which it is moulded: it appears alſo in amorphous maſſes pretty voluminous. Nothing certain can be ſaid in regard to its poſition; but it may be affirmed that it is found in the cavities or fiſſures of primitive mountains. We do not think that it has ever yet been found in its proper place by any naturaliſt; and the caſe is the ſame with the other productions of St. Gothard. The dealers in cryſtals go in queſt of them, and ſell them to travellers.

VIII. *Note on a Variety of carbonated Lime found near Port Seguin, Department of Vienne. By* C. Cressac, *Engineer of Mines* *.

THIS variety, which has not yet been deſcribed, reſults from a combination of the three following laws of decrement:

1ſt, That which produces the priſmatic by a decrement of two rows in the inferior angle *e* (fig. 5. Pl. III.)

2d, That which produces the inverſe by a row on the right and left of the angle E.

3d, That which produces the equi-axis by a decrement of one row on the edge B.

The repreſentative ſign of this variety, repreſented fig. 6, is $e^{2}_{c}E^{1}_{f}E^{1}_{g}B$; it has been called by C. Haüy *co-ordonate carbonated lime.* This name is deduced from the poſition of the facets produced by the three decrements in queſtion.

* From the *Journal des Mines*, No. 67.

Theſe

These facets are situated on the same side, and are separated by parallel ridges.

Inclination of c to g	116°	33′	54″
——— of c to f	153	26	6
——— of g to f	143	7	48.

IX. *Experiments and Observations on certain Stony and Metalline Substances which at different Times are said to have fallen on the Earth; also on various Kinds of Native Iron.* By EDWARD HOWARD, *Esq. F.R.S.*

[Concluded from p. 336 of our last Volume.]

THE connection which naturally exists between one mass of native iron and another, immediately turns our attention to the native iron in Siberia, described by Pallas; and this, we are told, the Tartars considered as a sacred relic, which had dropped from heaven. The nickel found in the one mass, and the traditionary history of the other, not to compare the globular bodies of stone from the Benares with the globular concavities and the earthy matter of the Siberian iron, tend to the formation of a chain between fallen stones and all kinds of native iron. How far any real affinity exists between these several substances, very obliging friends have afforded me an opportunity to form some judgment. I am indebted to Mr. Greville and Mr. Hatchett for portions of almost every known native iron; and the count de Bournon has done me the favour particularly to describe them as follows.

Description of various Kinds of Native Iron. By the Count de Bournon.

The great number of particles of iron, in a perfectly metallic state, contained in the stone from Bohemia, and the said particles being so near each other, naturally lead to some reflections respecting the existence of native iron, which, by many mineralogists, is still considered as problematical. Let us suppose for a moment, that these particles of iron were to approach still more nearly to each other, so as absolutely to come into contact, and in that manner to form a kind of chain, folded upon itself in the interior part of the substance, and leaving a great number of cavities between the links of the chain so folded. Let us then suppose, that the earthy substance with which these cavities are filled, being very porous, and having but a small degree of consistence, should (as may happen by a variety of causes) be destroyed. It is

plain, that if ſuch a deſtruction were to take place, the iron alone would remain; and, being thus left bare, it would appear in the form of a maſs, more or leſs conſiderable, of a cellular texture, and as it were ramified; ſuch a form, in ſhort, as that in which moſt of the native irons we are acquainted with have been found. May it not be fair to attribute to ſuch an origin the native iron found in Bohemia, a ſpecimen of which was preſented by the Academy of Freyberg to baron Born, and which came, with the reſt of his collection, into the hands of Mr. Greville? May not ſuch alſo, notwithſtanding the enormity of its bulk, be the origin of the maſs of native iron found in Siberia, near Mount Kemirs, by the celebrated Pallas?

We have already ſeen, in the reſults of the analyſes made by Mr. Howard, of the various ſtones above deſcribed, that he conſtantly found a certain proportion of nickel mixed with the iron they contained. This circumſtance recalls to our notice the obſervations that were made by Mr. Prouſt, ſome time ago, reſpecting the mixture of nickel in the native iron of South America; and tends to give ſome additional ſupport to the opinion hinted at in the foregoing paragraph.

The circumſtances juſt mentioned naturally gave to Mr. Howard, as well as to me, a deſire to know whether the native iron from Siberia, and that from Bohemia, were alſo mixed with nickel. Mr. Howard, conſequently, loſt no time in proceeding upon this important inveſtigation. The native iron of Siberia preſents ſome very intereſting peculiarities, and has often been referred to, but has not yet been properly deſcribed; it is therefore with great pleaſure that I add the following deſcription of it, and of ſome other kinds of native iron, to the deſcription I have already given of the various ſtones ſaid to have fallen on the earth.

I feel the greater ſatisfaction in doing this, as the noble collection of Mr. Greville contains two ſpecimens of this iron, in perfect condition; one of which weighs ſeveral pounds, and was ſent to Mr. Greville by Mr. Pallas himſelf: on this account, therefore, I enjoy an advantage that many of the authors who have ſpoken of this iron probably wanted.

One of theſe pieces has a cellular and ramified texture, analogous to that of ſome very porous and light volcanic ſcoria; this is the uſual texture of the ſpecimens of this kind of iron, which are preſerved in the various mineralogical collections in Europe. When it is attentively examined, there may be perceived in it, not only empty cells, but alſo impreſſions or cavities, of greater or leſs depth, and ſometimes perfectly round, which appear evidently to be the reſult of the com-

preſſion of hard bodies which were ſituated there, and which, when they came away, left the ſurface of theſe cavities quite ſmooth, and having the luſtre of poliſhed metal. Here and there, in ſome of theſe cavities, there remains a tranſparent ſubſtance, of a yellowiſh green colour, of which I ſhall treat more particularly when I come to the deſcription of the ſecond of the ſpecimens above mentioned. It is very clear that the cavities here ſpoken of owe their exiſtence to this tranſparent ſubſtance; and that the poliſh of the cavities ariſes merely from the compreſſion of the ſaid ſubſtance, and is the natural conſequence of its ſurface having been in perfect contact with that of the iron.

This iron is very malleable: it may be eaſily cut with a knife; and may be as eaſily flattened or extended by means of a hammer. Its ſpecific gravity is 6487; which, however, is very much under that of iron which has been merely melted, and has not been forged. The ſpecific gravity of the native iron of Bohemia, which is nearly as malleable and as eaſy to be cut, is ſtill leſs: I found it not to exceed 6146. This low degree of gravity appears to be owing partly to the oxidizement of the ſurface of the iron, and partly to there being, in the interior part of its ſubſtance, a number of ſmall cavities, which are often rendered viſible by fracture, and which have their ſurfaces alſo oxidized. The fracture of this iron preſents the ſame ſhining and ſilvery white colour as the common caſt iron known by the name of white caſt iron: but its grain is much ſmoother and finer; it is alſo much more malleable when cold. Bergman ſays that this iron is brittle when heated to a red heat. I have frequently tried it in that ſtate, and have conſtantly found it to be malleable. The ſame remark may be applied to the native iron from South America, and alſo to that from Senegal.

The ſecond of the two ſpecimens mentioned above, and which weighs ſeveral pounds, preſents an aſpect that differs, in ſome reſpects, from that of the preceding ſpecimen. The moſt conſiderable part of it forms a ſolid compact maſs, in which there is not to be perceived the ſmalleſt appearance of pores or cavities; but there ariſes upon its ſurface a kind of ramified or cellular part, ſimilar, in every reſpect, to the ſpecimen already deſcribed, and every where completely connected with the ſubſtance of the maſs itſelf.

If the compact part of this piece is examined with attention, it will be perceived that it is not entirely compoſed of iron in the metallic ſtate, but that it is mixed with nearly an equal quantity of the tranſparent ſubſtance of a yellowiſh green colour, (ſometimes alſo of a greeniſh yellow,) already

ſpoken of in the deſcription of the other ſpecimen. This ſubſtance is mixed with the iron in ſuch a manner, that if the whole of the former could be removed, the remaining part would conſiſt merely of iron in the metallic ſtate, and would preſent the ſame cellular appearance as the preceding ſpecimen, and the ramified or cellular part of the ſpecimen now deſcribed.

This ſtony part, ſeparated from the iron, appears in the form of ſmall nodules, generally of an irregular ſhape, but ſometimes nearly globular: they have a perfectly ſmooth and ſhining ſurface, ſo as very often to preſent the appearance of ſmall balls of glaſs; a circumſtance that has led many perſons to ſuppoſe them the reſult of a real vitrification. Some of theſe nodules have ſeveral irregular facets, produced by the compreſſion of the iron in which they were incloſed; but I have never obſerved in them any appearances that could lead me to ſuſpect they had the ſlighteſt tendency whatever to aſſume a determined cryſtalline form.

This ſubſtance is always more or leſs tranſparent. It is ſufficiently hard to cut glaſs, but has no effect upon quartz. It is very brittle: its fracture is uſually conchoid; but I could perceive that it broke in any particular direction, in ſuch a way that I could conſider the fracture as a natural one. It becomes electric by friction. Its ſpecific gravity is from 3263 to 3300. It is very refractory: I kept it, for ſome time, expoſed to a degree of heat ſufficiently ſtrong to oxidize, to a conſiderable depth, the iron crucible in which it was placed, without its having undergone any alteration, except that of having acquired a greater degree of intenſity in its colour. Its tranſparency was not at all diminiſhed. I think, therefore, there is not the ſmalleſt reaſon to allow any probability to the opinion that it ought to be conſidered as a kind of glaſs.

Of all ſubſtances hitherto known, that with which it ſeems to have the greateſt analogy is the peridot, (the chryſolite of Werner,) to which ſome mineralogiſts have referred it. The reſult of Mr. Howard's analyſis of it is nearly the ſame as that of the analyſis of the peridot made by Mr. Klaproth.

The hardneſs and infuſibility of this ſubſtance are nearly the ſame as thoſe of the peridot; but it ſeems to have a rather leſs degree of ſpecific gravity: that of two very perfect cryſtals of peridot I found to be from 3340 to 3375. The cryſtalline forms of the ſubſtance here deſcribed, if ever we ſhould be able to determine them, would clear up our doubts reſpecting the analogy between the two ſubſtances. If we conſider the compact part of the ſpecimen now treated of, particularly the ſtrong connection that appears to exiſt between the iron and the

the tranſparent ſubſtance, and the great reſiſtance we experience when we attempt to ſeparate them, we cannot help being ſurpriſed, that almoſt all the ſpecimens of this maſs of metallic iron that have been brought to Europe are in the cellular ſtate already deſcribed, owing apparently to the total, or almoſt total, deſtruction of the tranſparent ſubſtance. But, beſides the fragility of this ſubſtance, the ſpecimen in queſtion helps very much to explain the above circumſtance, inaſmuch as many of the nodules of the tranſparent ſubſtance belonging to it are in a ſtate of real decompoſition. In that ſtate, they are changed into a white opaque ſubſtance, which, upon being lightly preſſed or ſqueezed between the fingers, crumbles into a gritty dry powder. This decompoſition may be obſerved to have taken place in various degrees: in many of the nodules, the ſubſtance is merely become friable, without being much altered in its appearance; whereas, ſome of thoſe which are in a ſtate of complete decompoſition are of an ochreous reddiſh yellow colour: it is, however, eaſy to diſtinguiſh that this colour does not belong to them, but is owing only to the oxidizement of the adjacent particles of iron.

From the above obſervations it will not be difficult to conceive the poſſibility of the total, or nearly total, deſtruction of the tranſparent ſubſtance; and alſo, the appearance the pieces of iron muſt naturally preſent when deprived of it. I cannot help obſerving likewiſe, that there appears to exiſt a very intereſting analogy between theſe tranſparent nodules and the globules I deſcribed as making part of the ſtones ſaid to have fallen on the earth. This analogy, though not a very ſtrong one, may lead us to ſuppoſe that the two ſubſtances are ſimilar in their nature, but that the globules are leſs pure, and contain a greater quantity of iron.

The native iron from Bohemia is a compact maſs, ſimilar to the compact part of the large ſpecimen of iron from Siberia, which has juſt been deſcribed: like that, alſo, it contains a number of globular bodies or nodules; but they are not in ſuch great proportion as in the Siberian iron. They are beſides perfectly opaque, and very much reſemble the moſt compact of the globules belonging to the ſtones ſaid to have fallen on the earth.

Examination of the Iron from South America.

I have already obſerved, that my experiments coincided with thoſe of Mr. Prouſt. He obtained 50 grains of ſulphate of nickel from 100 of this maſs. The proceſs I have ſo fre-

quently mentioned yielded me 80 grains of oxide of iron from 62 of the metal; which indicates about 7½ of nickel, or about 10 per cent.

Examination of the Siberian Iron.

100 grains of this iron gave 127 of oxide of iron: hence it ſhould contain about 17 per cent. of nickel.

The yellow ſubſtance belonging to this iron was analyſed in the ſame way as the globular bodies, and the earthy parts, of the ſtone from Benares.

The proportions reſulting from the analyſis of 50 grains, and from ſome previous experiments on other particles, were,

Silica - - - - -	27
Magneſia - - - -	13½
Oxide of iron - - -	8½
Oxide of nickel - - -	½
	49½

Examination of the Bohemian Iron.

26½ grains of this metal left about 1½ grain of earthy matter, inſoluble in nitric acid; and, by ammonia, afforded 30 grains of oxide of iron, inducing an eſtimation of nearly 5 of nickel.

Examination of Iron from Senegal, brought by General O'Hara, and given to me by Mr. Hatchett.

In this experiment, 199 grains of oxide were produced from 145 grains of metal: hence there may be an eſtimation of 8 grains in 145, or between 5 and 6 per cent. of nickel.

It will appear, from a collected view of the preceding pages and authorities, that a number of ſtones aſſerted to have fallen under ſimilar circumſtances have preciſely the ſame characters. The ſtones from Benares, the ſtone from Yorkſhire, that from Sienna, and a fragment of one from Bohemia, have a relation to each other not to be queſtioned.

1ſt, They have all pyrites of a peculiar character.

2dly, They have all a coating of black oxide of iron.

3dly, They all contain an alloy of iron and nickel. And,

4thly, The earths which ſerve to them as a ſort of connecting medium, correſpond in their nature, and nearly in their proportions.

Moreover, in the ſtones from Benares, pyrites and globular bodies are exceedingly diſtinct. In the others they are more or leſs definite; and that from Sienna had one of its globules

globules tranſparent. Meteors, or lightning, attended the deſcent of the ſtones at Benares and at Sienna. Such coincidence of circumſtances, and the unqueſtionable authorities I have adduced, muſt, I imagine, remove all doubt as to the deſcent of theſe ſtony ſubſtances; for to diſbelieve, on the mere ground of incomprehenſibility, would be to diſpute moſt of the works of nature.

Reſpecting the kinds of iron called native, they all contain nickel. The maſs in South America is hollow, has concavities, and appears to have been in a ſoft or welding ſtate, becauſe it has received various impreſſions.

The Siberian iron has globular concavities, in part filled with a tranſparent ſubſtance, which, the proportional quantity of oxide of iron excepted, has nearly the compoſition of the globules in the ſtone from Benares.

The iron from Bohemia adheres to earthy matter ſtudded with globular bodies.

The Senegal iron had been completely mutilated before it came under my examination.

From theſe facts I ſhall draw no concluſion, but ſubmit the following queries:

1ſt, Have not all fallen ſtones, and what are called native irons, the ſame origin?

2dly, Are all, or any, the produce or the bodies of meteors?

And, laſtly, Might not the ſtone from Yorkſhire have formed a meteor in regions too elevated to be diſcovered?

Specimens of the Benares and Yorkſhire ſtones have been depoſited, by the preſident, in the Britiſh Muſeum.

X. *Conſiderations on Dr.* Hutton's *Theory of Rain: read before the Aſkeſian Society, in the Seſſion* 1801-2. *By* Luke Howard, *Eſq. F. L. S.*

In an eſſay preſented to the Royal Society of Edinburgh, and inſerted in the firſt volume of their Tranſactions, Dr. Hutton inveſtigates the rule directing the action and effects of heat and cold on the atmoſphere, in order to eſtabliſh a theory of rain on this principle, that the mixture of portions of air ſaturated with water, and at differing temperatures, will uniformly produce the condenſation of a portion of water.

"This rule of condenſation," ſays Dr. Hutton, "may be applied to the theory of rain, which is the diſtillation of water firſt diſſolved in the atmoſphere, and then condenſed from that ſtate of ſolution.

" The cauſe of rain, though often exerted, will not always produce the full effect; a ſcanty condenſation of aqueous vapour produces *miſts* on the earth, and *clouds* in the atmoſphere above: and taking the gradation from one extreme of tranſparent atmoſphere to the other of the denſeſt cloud, from the falling of the gentleſt miſt to the heavieſt rain, hail, and ſnow, we have an indefinite variety of appearances, all flowing from one ſimple principle."

On the viſible ſteam produced by the breath of animals and by heated water, in a cold atmoſphere, the author remarks that this appearance is not the effect of the genuine principles of heat and cold; that, to explain it, the knowledge of a particular law is requiſite; and that the effects of heat and cold, in relation to air and vapour, are not uniform. The law alluded to is thus laid down:

" The diſſolving power of air on water may vary in different proportions to the heat. The ſolution may vary as the heat, or in a greater or leſs ratio, i. e. the increments of each may be conſtant, or, thoſe of the heat being conſtant, the increments of the ſolution may be accelerated or retarded.

" This may be repreſented geometrically (ſee fig. 7, Plate III). Let C H repreſent the ſcale of the thermometer; *a m b r*, perpendicular ordinates, the quantity of water held in ſolution by a given quantity of air of the temperatures *a* and *b*. Join *m r*, and draw the curves *m g r*, *m d r*: then it is evident that the ordinates to *m r* mark a ſolution varying as the heat; the ordinates to *m d r* a ſolution varying in a greater ratio, and to *m g r* in a leſs ratio than the heat.

" The ordinates to line *m r*, drawn from a point denoting the temperature of the mixture, repreſent the quantity of water contained (diſſolved or not) in a unit of the mixture; for the ordinates *m a r b* are as the quantities contained in a unit of air of temperatures *a* and *b*; and as upon mixture the heat and water are uniformly diſſolved (diffuſed?), they vary in the ſame proportion, and may be expreſſed by the ſame meaſure.

" Suppoſing equable ſolution, mix equal portions of ſaturated air, temperatures 10 and 40; the mixture of temperature 25 is repreſented by *o p*, which alſo repreſents the quantity of water in a unit of the mixture, and the quantity held in ſolution by a unit of air at temperature 25.

" So two portions of temperature 40, being mixed with one of temperature 10, the temperature produced 30 will be expreſſed by *u q*.

" In the curve *m d r* let equal portions of the ſolution at

40 and at 10 be mixed; then op is the quantity of water contained in this mixture at the mean heat 25, while oe is the ordinate of ſolution: conſequently ep is the quantity of water that cannot be retained in ſolution in the mean temperature produced by the mixture.

"In the curve mgr let equal portions at 10 and 40 be mixed; and the ordinate being drawn in the mean 25, sk will be the whole power of ſolution, and the quantity of water that air is capable of diſſolving in this degree of heat; but op being the quantity of water actually in the mixture, the air is underſaturated by the quantity pk.

"Thus the actual curve of evaporation being known, the effect of any mixture of two portions at different temperaments may be aſcertained. If the ſolution of water in air increaſes equally with the heat, there will be neither ſuper- nor under-ſaturation in a mixture of portions at different temperatures.

"If the ſolution increaſes with the heat but in a decreaſing rate, there will be under-ſaturation; if it increaſes with the heat but in an increaſing rate, there will be ſuper-ſaturation.

"The laſt caſe applies to the phænomena of breath and ſteam * rendered viſible in mixing with air colder than themſelves, and to various appearances that may occur in mixing together ſeveral portions of air differently ſaturated with humidity and at different temperatures: for it is not every mixture of air at different temperatures that forms a viſible condenſation, this effect depending on the degree of ſaturation with humidity. But if two portions of the atmoſphere, both ſaturated with humidity, ſhould be mixed, let there be but a difference in their temperatures, a condenſation proportionate to this difference will take place.

"At preſent, from the influence of the aſcending ſun,

* Aqueous gas at 212° (or ſteam) produces viſible clouds in mixing with air at a lower temperature; but ſteam is not a ſolution of water in air, neither is this appearance peculiar to it, but attends the cooling (in contact with air) of the tranſparent vapours of camphor and all volatile oils, as well as of benzoic acid and other ſubſtances quite inſoluble in air. The ſublimation of the latter very aptly exemplifies to a ſpectator of it that momentary production of ſnow which has been witneſſed when the intenſely cold and denſe air of northern climates has been ſuddenly admitted into the moiſt and warm atmoſphere of the apartments in uſe there.

Viſible ſteam ariſes from the differing capacities of air and of vapour for caloric. The former, in acquiring temperature from the latter, robs it of a portion of its *conſtituent* caloric: hence a momentary reproduction of water, which is afterwards depoſited or diſſolved according to circumſtances. *Note by the Author of the preſent Eſſay.*

two

two oppoſite currents of air are formed in the ſummer hemiſphere, one moving along the ſurface of the earth from the pole to the equator, the other flowing above. Theſe oppoſite currents, while ſeparate, might paſs each other without producing rain; but when ſufficient portions are mixed, not only clouds but ſhowers will be produced, ſince the ſudden formation of a mean degree of heat, in the mixture of two portions of different temperatures, muſt condenſe a quantity of vapour ſufficient to form rain.

"Without this law of condenſation of evaporation neither rain nor dew could take place any where in the ſummer hemiſphere, perhaps not even in tropical latitudes: there would be evaporation and a general tendency to ſaturate the atmoſphere with water, but the mixture of different portions of air would only temper the ſaturation without producing a condenſation of vapour in the mean degrees of heat. At night, from the influence of the cold, the atmoſphere would become gradually clouded; this cloudineſs would increaſe to a general diſtillation of condenſed vapour, which would be uniformly continued until the returning ſummer ſhould change the ſtate of condenſation to evaporation; and inſtead of the beautiful return of ſeaſons, tempered with various degrees of heat and refreſhing ſhowers, ſix months rain and ſix months drought would follow each other in an invariable ſucceſſion."

Such is the hypotheſis which Dr. Hutton is willing we ſhould conſider as the theory of rain, and which he proceeds to apply to natural appearances; ſeeming to experience no great difficulty in ſolving by it every problem that occurs, as the ſolſtitial, equinoctial, and other periodical rains, the comparative ſtate of different climates and of land and ſea, as to its frequency and quantity, &c. But, if we except a ſhort remark on hail and thunder ſtorms (which ſeems only to give occaſion to a confeſſion of our imperfect knowledge of atmoſpherical electricity), in no inſtance does the doctor avail himſelf of the aid of any other principle than the mixture of currents of air in traverſing the irregular ſurface of the globe, and conſequent precipitation of water, to account for the whole train of phænomena conſtituting the ſubject of meteorology.

The ſimplicity of this theory, the impoſing air of a diagram at its introduction, the ingenious and deſcriptive manner of the application, all contribute to render it ſufficiently plauſible. It is rather extraordinary that the objections urged againſt it by De Luc * ſhould have extended no further than

* Idées ſur la Météorologie, tome ii. p. 67.

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it appears they did. It would however be readily granted, I ſuppoſe, by each of theſe philoſophers, that hypotheſes, of whatſoever kind, ought not to be admitted into ſcience without the moſt rigorous examination, and that doubt has a right to keep the door ſhut until ſome paſſport of the demonſtrative kind is obtained either from nature or experiment. A geometrical repreſentation of what *may be* is not a ſufficient foundation whereon to aſſert what *is* a law of nature. Let us therefore examine how far this theory, which does not appear to be ſupported by any direct experiment, will bear the teſt of the excellent and deciſive ones whereon the doctrine of capacities has been eſtabliſhed by Black, Crawford, and Lavoiſier.

The author firſt aſſumes, as a law of nature, the poſition, that the ſolution of water in air increaſes with the temperature (heat), but in an increaſing ratio. On this he grounds a ſecond, the ſubſtance of which is, that if two portions of air, ſaturated with water and at differing temperatures, be mixed, the mean proportion will not be ſoluble at the mean temperature, and therefore a part will be precipitated.

The firſt poſition may be true, or it may not; perhaps nothing ſhort of actual experiment can ſatisfactorily aſcertain the actual curve of evaporation *.

The ſecond depends entirely on conditions which the doctor has taken for granted in each of the three caſes of evaporation ſtated by him, and which, on the received principles of caloric, can belong to no one of them. Theſe conditions withdrawn, the theory of rain, like its ſubject, falls to the ground, and the diagram proves as unſubſtantial as the bow with which the ſhower is decorated. To make this appear, it is only neceſſary to produce the following practical reſults, which apply equally, whether we regard caloric as matter or motion.

A homogeneous ſubſtance, or two ſubſtances having equal capacities for caloric, being mixed in equal portions at unequal temperatures, the temperature of the mixture is found to be in the arithmetical mean.

But heterogeneous ſubſtances, and thoſe in other reſpects homogeneous, but differing in capacity, being mixed in like manner, give a temperature which either exceeds or falls below the arithmetical mean, and approaches towards that of the two ſubſtances which poſſeſſed the greater capacity.

* Experiments deciſive of this very queſtion were made about this time, and the reſults preſented to the Literary and Philoſophical Society of Manchester by John Dalton, eſq. We ſhall have occaſion to notice his paper further on.

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The capacity of water (which Crawford terms the comparative heat) being taken at 1,000, that of air proves by his experiments to be as 1,790, and that of aqueous vapour as 1,550, at equal weights and temperatures.

Then if to dry air we add ſucceſſive portions of water at increaſing temperatures, we are forming a *compound* (not merely heating a *homogeneous* maſs), the nature of which, as in all other reſpects, ſo in that of the capacity for caloric, muſt ſtill continue approaching to that of aqueous vapour.

Now in any two portions of this compound, *formed* at different temperatures, the capacities will differ. It will be leſs in that which was ſaturated at the higher temperature; and whatſoever may have been the preciſe rate at which the ſolution advanced at increaſing temperatures, the mixture of the two portions will not produce a temperature in the arithmetical mean, but below it, as being moſt influenced by the drier portion.

Thus is the principal condition invalidated, viz. that portions of ſaturated air at differing temperatures will poſſeſs, after mixture, a temperature in the arithmetical mean. This argument may appear at firſt ſight ſtill to favour the concluſion reſpecting the mixture in the curve *m d r*, ſince, if precipitation take place at the mean temperature, much more ſhould it at a lower than the mean: but perhaps it may be eaſy to demonſtrate, on the ſame principles as before, that the temperature of ſuch a compound, as it reſults from this circumſtance of mixture only, will in no caſe affect the ſtate of ſolution, and that neither ſuper- nor under-ſaturation will enſue therefrom.

We will take for this purpoſe the curve *m d r*, and examine the real circumſtances of a ſolution advancing with the temperature but in an accelerated ratio; premiſing that the queſtion regards the effects of heat (caloric) *only* as the cauſe both of increaſed temperature and increaſed ſolution, and that, according to Crawford, equal additions of this (the capacity of the receiving body continuing unchanged) produce equal expanſions in the common thermometer.

That the ſolution of water in air goes on increaſing with the temperature of the compound is true, and it is equally ſo that it increaſes *at the expenſe of that power which gives the temperature*; for water held by air is itſelf in the ſtate of gas, and gas of whatſoever kind requires a large proportion of caloric for its conſtitution, which is not at all meaſurable by the thermometer.

Suppoſing therefore a unit of *dry* air at a certain temperature to conſiſt of 0,005 meaſures of liquid baſe and 0,995 caloric,

caloric, and that one part of caloric will raiſe its temperature one degree in any part of the ſcale; if we wiſh to convert this into a unit of *moiſt* air at the ſame temperature, it will not be ſufficient merely to add the proportion of water, ſuppoſe 0,001; for this water, being itſelf a *liquid baſe*, will require nearly as much *additional* caloric to conſtitute it gas, as the portion of air which was neceſſarily excluded from the unit took away with it. When we have added this proportion of caloric (which would have raiſed the dry air many degrees in temperature) together with the water, we ſhall have a unit of ſaturated air.

Further, if we would raiſe the temperature of the latter 10, 20, or 200 degrees, and ſtill preſerve the ſaturation, we ſhall find it impoſſible to proceed without an expenſe of power adequate to the rate of ſolution, beſides that proportion which is employed in raiſing the temperature through thoſe ſucceſſive intervals of the ſcale which are taken as the ſtandard of ſolution.

Now, in the caſe of equably advancing ſolution, if, as often as the thermometer has riſen 10°, a quantity of caloric equal to 100° has been imperceptibly ſupplied in addition, this is of no importance in the iſſue, ſince the temperature is ſtill a true *proportionate* meaſure of the power of ſolution in the extremes and in the mean: but in thoſe of accelerated and retarded ſolution it is otherwiſe; for here the very terms of the propoſition require that, as we advance in the ſcale, each degree of temperature may anſwer to 10, 12, 16, 24, of ſolution, or inverſely, and conſequently to ſimilar proportions of *added power*. Now if in each unit ſucceſſively ſaturated at different degrees there enters the due proportion of power which it needs muſt, then in every mixture that can be made of them the total power of ſolution as well as the whole quantity of water will be preſent, and there will be neither ſuper- nor under-ſaturation let the temperature reſulting from the mixture be what it may *.

Admitting, therefore, that caloric, or the *cauſe of temperature*, is alſo a neceſſary conſtituent part of aqueous vapour in whatſoever way it be formed, and that the doctrine of capacities is well founded, we muſt reject the theory of Dr. Hutton altogether.

P. S. Whether the phraſe of "the diſſolving power of air on water" was connected in the mind of Dr. Hutton with

* The remainder of the paper, as read before the ſociety, is ſuppreſſed by deſire of the author, who has communicated what follows in its place, and in which his reaſons for this will appear.—EDITOR.

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the idea of ſome other power operating jointly with the heat, ſuch as an attraction between the baſe of air and water, I am not qualified to determine; but were it ſo, this would in no-wiſe affect the previous reaſoning, as the concluſion reſts entirely on the temperature, *i. e.* in the doctor's view, the caloric preſent, though they are in fact two diſtinct conſiderations which he has blended.

In the concluding part of this eſſay, as it was originally written, I had diſcuſſed the ſubject of the ſolution of water in air, and the ſeveral modes of its precipitation, on chemical principles; regarding moiſt air as a ternary compound of baſe of air, water, and caloric, formed and ſubſiſting by chemical attractions, and decompoſed by the operation of the ſame.

Having ſince peruſed the excellent work of my friend John Dalton *, which I have before alluded to, and having ſeen and repeated ſome of the principal experiments therein detailed, I muſt acknowledge that, although I might plead the authority of a Kirwan † in ſupport of the chemical theory of evaporation, I am now diſpoſed to give up the idea of a proper *ſolution* of water in air *in toto*.

It appears to me that nothing need be more clear, ſimple, and concluſive, than the experiments and deductions by which the author attempts to prove that the evaporation of water and ſeveral other liquids is a proceſs uniformly regulated by their temperature, the effect of the latter in equal ſurfaces being the ſame *in vacuo* and under the full preſſure of the atmoſphere; the preſence of which has no other influence than by its motion to multiply the ſurface of the liquid and carry away the vapour produced; whence the difference of quantity evaporated in equal times in a moving and a ſtagnant atmoſphere. The ſolvent power of air on water may alſo, therefore, be ſafely claſſed among thoſe cauſes which are not needful to the effect in queſtion, and therefore not to be retained in philoſophical reaſoning.

* Experimental Eſſays on the Conſtitution of mixed Gaſes: on the Force of Steam or Vapour from Water and other Liquids in different Temperatures, both in a Torricellian Vacuum and in Air; on Evaporation; and on the Expanſion of Gaſes by Heat.—*Manchester Memoirs*, vol. v. part 2. 1801.

† Of the Variations of the Atmoſphere, inſerted in the Iriſh Tranſactions 1801.

XI. *General Conſiderations on Vegetable Extracts.* By C. Parmentier.

[Concluded from p. 386 of our laſt Volume.]

Juices of Plants.

To prepare theſe juices, they recommend to collect the plants when they are in full vegetation, to clean them carefully, to pound them in a marble mortar, to preſs them incloſed in a hair bag, after having added to them a little water, but only when they are either a little too aqueous or too mucilaginous.

All the ſap-veſſels of the plant, or others, are broken by the action of the peſtle; all the liquids which they contained flow off, together with the green fecula and the attenuated remains of the vegetable.

They recommend to purify the juices either by reſt, or by the heat of boiling water, or by means of the white of an egg, or by making them paſs through gray paper.

The firſt method is fit for the juices of fruits.

The ſecond may be employed for all the juices of herbs deſtined to make extracts.

The third may be employed for all juices, infuſions, or decoctions, that do not contain tannin.

The fourth is neceſſary for all juices the virtues of which exiſt chiefly in the volatile principles.

It is preferred in pharmacy for magiſterial juices, whether they be volatile or not; the two viſcous juices excepted.

Maceration—Infuſion—Decoction.

In maceration, the cold water is attracted by the dry vegetable ſubſtances: it introduces itſelf into them, ſwells them up, and renders fluid whatever is ſoluble.

It has been found that maceration is ſufficient to obtain from quaſſia, and even quinquina, the real active parts contained in them.

In infuſion, caloric more abundant than in maceration renders the water more penetrating, more active, and more ſolvent; it becomes charged with a much greater number of the principles of the vegetable. The preparers of medicines make uſe of it in preference for dry herbs and for leaves, which, like ſenna, for example, cannot bear ebullition without loſing their virtues.

In decoction, the water ſaturated with caloric acquires a much greater energy: it penetrates in a more intimate manner

ner the vegetable ſubjected to its action; it forces to become ſoluble the ſubſtances which were not ſo at a lower temperature; it melts and ſeparates thoſe which are oily or reſinous; it diſſipates thoſe which are volatile; and ſeveral of them it combines or decompoſes.

They expoſe to the action of boiling water thoſe plants or parts of plants only which are exceedingly hard, and in which there exiſts nothing volatile; and they often ſubject theſe ſubſtances to maceration and infuſion before they expoſe them to ebullition.

In evaporation, the water charged with the ſoluble principles of the vegetables gradually abandons them to unite with caloric, and to form with it a volatile fluid known under the name of vapour: by theſe means, the principles before diluted become concentrated, and aſſume conſiſtence, the ſtate and name of extracts.

They preſcribe a gentle fire for the evaporation of the juices, macerations, and infuſions, and a ſtronger fire for decoctions, taking care to chooſe large and ſhallow evaporating veſſels, and to ſtir the liquors to facilitate the evaporation of the water, and to prevent the extract from being burnt.

And to prevent that alteration of which the principles of vegetables, when highly diluted with water and expoſed to the heat of an evaporation too long continued, are ſuſceptible, they recommend to employ only the neceſſary quantity of water, paying attention to the ſolidity of the ſubſtances expoſed to maceration, infuſion, and decoction. They take care alſo to employ for all their operations very pure water, ſenſible that it is only when it is in this ſtate that it is fit for boiling pulſe.

During the evaporation of ſeveral juices or decoctions, ſome phænomena occurred which did not eſcape their notice.

They remarked, when preparing ſeveral extracts which they called ſaponaceous, that liquors became turbid; that their ſurface was covered with a pellicle which ſeparated into flakes, were precipitated, and formed incruſtations ſuſceptible of being burnt at the bottom of the evaporating veſſels.

It was Baumé in particular who paid attention to theſe precipitates; he ſays they were ſaline.

The preparers of ſuch medicines have alſo found that, during the cooling of the decoctions of roots or barks abundant in reſinous matter, and during the evaporation of ſeveral of theſe decoctions, precipitates more or leſs abundant were formed, which, according to the opinion of Baumé, were owing to the reſin, more or leſs altered, of the vegetables employed.

Theſe

These precipitates, some of which were thought by Baumé to be saline and others resinous, have been considered by Pelletier as earthy substances, and are ascribed by the modern chemists to the union which several of the immediate principles of vegetables contained in the juices have formed with oxygen, which makes them lose their solubility in water.

C. Deschamps junior, apothecary at Lyons, is of opinion that they are a mixture of lime, extractive matter, oily or resinous substances in some, and an astringent resinous substance in others; sometimes of a little calcareous salt, and sometimes of a little silex or alumine.

As the observations and experiments on which he founds his opinion may, by laying aside what he thinks unfavourable to oxygen, be exceedingly useful in the preparation of extracts, we refer to his memoir published in the *Annales de Chimie* for the year 7.

It results, from the most essential facts announced in the memoir of C. Deschamps:

1st. That there exists, in the vegetable juices or decoctions which he subjected to examination, a neutral salt, the base of which has always been found to be lime, sometimes mixed with a little silex and alumine, and of which the acid is often different.

2d. That this saline combination, not very energetic of itself, is weakened when diluted with water, and is easily destroyed by ebullition, like many others, when the acid in it is not in excess, while it maintains itself, and is not altered when the acid is superabundant in it.

3d. That the decomposition of this salt, when it takes place, is only momentary, since the deposits become redissolved towards the end of the evaporation by the same acid which has abandoned them; and which then, notwithstanding the loss it has sustained in its quantity, resumes sufficient force to re-establish things nearly in their first state.

Hence arises the necessity of not separating deposits which prevent acids from being acid and deliquescent.

4th. That these deposits, the major part of which is lime, which carries with it, more or less combined, sometimes an oily extractive, sometimes a resino-astringent substance, and sometimes a little essential salt, itself not being decomposed, do not take place when the juices are not diluted with water, when maceration and infusion are substituted for ebullition, and when the evaporation is effected in a gentle heat.

By uniting the facts contained in the memoir of C. Deschamps with the observations of the chemists above men-

tioned, we may ſee how extracts muſt be prepared in general: but there is one which requires peculiar proceſſes that muſt be made known.

1ſt. Both of the elder and buckthorn are made with juices which have been extracted 24 hours before from the berries of theſe two ſhrubs.

During that time, theſe juices become charged with the extractive colouring part lodged under the ſkin of the berries, and by theſe means acquire more virtue.

2d. Extract of juniper is obtained by maceration of freſh juniper berries which have been bruiſed. They are evaporated in a gentle heat, after being made to paſs through flannel.

It is ſaccharine and aromatic: it would be acrid and reſinous, if ebullition were employed. Baumé, however, has preſcribed it; but he made it light, and recommended not to bruiſe the berries.

3d. Extracts of caſſia and tamarinds are all products of the maceration and pulp of theſe fruits.

Infuſion of tamarinds, cold, is attended with the inconvenience of ſuffering their eſſential ſalt to be precipitated during the evaporation.

4th. Extract of the corn poppy is produced by carefully infuſing the dried flowers.

5th. That obtained from ſaffron is very abundant; almoſt the whole of its ſtamina are converted into extract; ſo that it may be conſidered as uſeleſs to ſubject them to this preparation, which, altering their virtue a little, does not reduce them to a leſs volume.

6th. The extract of coloquintida is made with a decoction of the pulp of that fruit freed from the ſeeds. To render it ſweeter, and make it leſs ſuſceptible of griping the bowels, it ought to be deprived of its reſin.

Baumé cauſed it to be rediſſolved in cold water. He filtrated the liquor, and the reſin remained on the paper. This operation he repeated three times.

7th. Opium is brought to us from Turkey. The practice of making it near the ruins of Thebes has been loſt. The inhabitants of Egypt ſtill cultivate the plant which furniſhes it; but only to eat the ſeeds, which they are fond of, as well as of all other emulſive ſeeds.

Opium is an extract prepared from the expreſſed juice of the leaves, ſtems, and heads of the white poppy.

That uſed in commerce is very impure. The preparer of opium diſſolves it in water, makes the liquor paſs through flannel,

flannel, and evaporates it in a balneum mariæ. When he wiſhes to make it more tranquillizing than narcotic, he ſubjects it to both the following preparations:

The firſt conſiſts in cutting the opium into ſlices, boiling it in the quantity of water neceſſary to diſſolve every thing ſoluble it contains, ſtraining the liquor, evaporating it to a half, putting it into a tin cucurbit immerſed in a ſand bath over a fire maintained three months night and day, adding water in proportion as it is evaporated, ſcraping from time to time the bottom of the evaporating veſſel, to prevent the reſin which is precipitated from being burnt, ſtraining the liquor when three months are elapſed, and then evaporating.

A ſolid extract, called opium, is obtained by long digeſtion of all the extracts of opium: this is the one moſt eſteemed by Baumé. The ſecond proceſs is that employed by Joſſe to extract the gluten from the farina of wheat.

The opium is expoſed under the cock of a veſſel which produces only a ſmall ſtream of water, where it is kneaded: its extractive matter is diſſolved, and the reſinous part remains in the hands; the liquor is then filtrated, and it is evaporated to the conſiſtence of extract.

The third method of correcting opium is that recommended by Baumé for freeing the extract of coloquintida from the prejudicial reſin which it contains, viz. ſolution, cold filtration, and evaporation. But as the reſin of opium is more difficult to be removed than that of coloquintida, theſe three operations are repeated ſix times ſucceſſively.

8th. It is cuſtomary to purify by ſolution and filtration extracts of the acacia, hypociſtis, cachou, and liquorice, ſold in the ſhops. But an exact pharmacopoliſt will prefer preparing the laſt-mentioned article himſelf from the liquorice of our gardens: he will treat it by infuſion, and will thus obtain a brown extract of a ſweet taſte and very agreeable, while the other is black and acrid, and often contains charcoal and always copper, both taken from the bottom of the baſon by ſcraping it with an iron ſpatula.

9th. Extract of ſenna ought to be made from an infuſion of the leaves: ſtrong decoction would add to the extractive ſubſtance given by infuſion, a mucilaginous matter which would weaken its virtue.

10th. Extracts of hemlock, ſtramonium, hyoſcyamus, and bella-dona, were prepared by Storck from the unpurified juices of theſe plants.

It is much better to evaporate theſe juices after they have been purified and mixed at the end of the baking, the green fecula being ſeparated.

11th. The dry extracts of La Garaye are all made by ſimple maceration evaporated in a balneum mariæ, or in a ſtove, on flat diſhes; they form very thin ſcales.

La Garaye filtered his liquors a ſecond time when they were half evaporated; but this ſecond filtration is uſeleſs if there exiſts no depoſit, and it is hurtful if there be one; becauſe in ſeparating it, inſtead of ſuffering it to be rediſſolved, the extract acquires the property of attracting moiſture more ſtrongly.

The proceſs employed by La Garaye for preparing his extracts alters as little as poſſible the ſubſtances they contain.

12th. Extracts made from ſuch freſh-gathered roots as contain mucous bodies in ſtates of ſolution and of inſolubility, that is to ſay, mucilage, properly called ſtarch, alſo have need, as already ſaid, of a preliminary preparation to make them loſe the latter ſubſtance, capable of becoming mouldy when by the aid of warm water it has aſſumed the ſtate of jelly.

But this ſtarch does not hurt extracts prepared with infuſions or decoctions of the ſame roots dried, becauſe the mucilage of the roots is deſtroyed or modified by the deſiccation.

13th. Several pharmacopoliſts having obſerved this change which deſiccation produces in the ſtate of the mucous part of plants, have thought that it would be of advantage to prepare extracts from dried plants, eſpecially in regard to plants highly mucilaginous, ſuch as burrage.

Experience has taught them that extracts more abundant, and which keep longer without alteration, may be obtained by this method.

Is the extractive principle increaſed by deſiccation at the expenſe of the mucilage, or does the mucilage by drying in the plants aſſume a ſtate which approaches very near to that of extractive matter?

14th. There are ſome extracts in which it is neceſſary to retain a reſino-gummy or extracto-reſinous ſubſtance: this may be effected by ſucceſſively treating the plant which contains it with water and with alcohol. The reſult of theſe two ſolutions, intimately mixed and properly concentrated, gives this kind of extract.

15th. Sometimes wine is employed in order to have only one infuſion to make, and to fulfil the ſame indication; but it is probable that the end propoſed in this caſe is not obtained.

Wine, indeed, beſides its not diſſolving ſo well the two required principles, is attended with the inconvenience of furniſhing not only the extractive ſubſtance proper to it, but alſo

alſo an acid, which muſt neceſſarily have a greater or leſs action on the extractive matter of the vegetables, change its nature, and increaſe in the extracts the tendency they have to deliqueſcence.

16th. Vinegar extracts very badly the principles of vegetables; it generally alters them, or is altered by them.

It may however be ſtill employed as a ſolvent in regard to ſquills, garlic, reſinous gums, and as a vehicle of the odours and colours of ſome flowers.

17th. Extracts by highly rectified alcohol are reſins; by weak alcohol they are reſins mixed with gummy or extractive ſubſtances.

Vegetable ſubſtances ſubjected to the action of alcohol are dry, and much divided: this action is aſſiſted by a degree of heat more or leſs conſiderable. The veſſel in which the operation is performed muſt be ſufficiently large to allow the vapours to circulate.

When the ſolution has been made and filtered, water is poured over it, and the alcohol abandons the reſin to unite with the water; or it is ſubjected to diſtillation, and the alcohol paſſes off in vapours, leaving the reſin free in the ſame manner.

18th. If jalap, for example, has been employed, to obtain the reſin, and if it be intended to procure the gummy extract of this root, the exhauſted reſiduum of the reſin muſt be treated with water, after which the infuſion is filtered and evaporated.

It reſults from theſe general conſiderations on vegetable extracts, that the pharmacopoliſt, if he proceeds methodically, will always have the ſatisfaction of furniſhing the healing art with medicines containing the whole of the immediate products of vegetables, and conſequently ſuſceptible of producing the effects which eſſentially belong to them.

XII. *Deſcription of a Three-blaſt Fuſing Furnace, conſtructed in the Chemical Laboratory of the French School of Mines. By* P. Torelli-Narci, *attached to the Council of Mines.*

THIS furnace is deſtined for fuſing different mineral ſubſtances, in order to aſcertain the nature of them; and the experience of ſix years has ſhown that it anſwers the intended purpoſe. By its means a very intenſe heat is obtained, and it was employed by C. Clouet for repeating his experiments

on the converſion of forged iron into caſt ſteel, which were attended with full ſucceſs.

Chemiſts who have ſeen this furnace ſeemed deſirous of being better acquainted with the conſtruction of it: the council even tranſmitted drawings of it to ſeveral perſons; and what has hitherto prevented a deſcription of it from being given was a deſire to aſcertain its power by longer uſe.

I long ago conceived the idea of a fuſing furnace, in which the wind was diſtributed in three tuyeres placed in its circumference, and at equal diſtances from each other; but I had no opportunity of realizing this idea till I became attached to the council of mines.

Nearly ſeven years ago a plan was in agitation for conſtructing in the laboratory of the ſchool a fuſing furnace capable of producing a very great degree of heat, in order to operate with facility and ſpeed on larger quantities of mineral, and conſequently to obtain more preciſion in the trials which might be made than had been obtained by the ſmall furnaces before employed for docimaſtic experiments.

I propoſed my ideas: they were approved by the council of mines; and I was ordered to cauſe the furnace I am about to deſcribe to be conſtructed. The principal difference between it and thoſe before uſed for the ſame purpoſe is, that in the preſent one the wind is introduced through three tuyeres, placed at equal diſtances from each other in its circumference, whereas in common furnaces it enters only by one.

This furnace is round, both outſide and inſide, and conſtructed of very refractory bricks, ſecured by iron hoops in ſuch a manner that they cannot be diſplaced. It reſts on a ſquare baſe of ſtrong maſon-work, raiſed to a ſufficient height above the ground to render it eaſy to manage.

The bellows are four feet in length, and the mean breadth of them is about 20 or 21 inches: they are of wood, and the joints are covered with white leather. The upper part conſiſts of five folds and two half folds; the inferior, of two folds and two half folds. They are placed 8 or 9 feet * above a wooden box, the joints of which are covered with leather, and into which the wind as it comes from the bellows is conveyed by a copper pipe, three inches in diameter, adjuſted to the upper part of the box. The box itſelf is ſupported by two iron bars built into the wall. From the lower part of this box deſcend, in a vertical direction, three pipes

* This height is arbitrary, it depends in part on the manner in which the bellows are diſpoſed, and on the height of the chamber in which the furnace is placed.

of

of copper, two inches in diameter, bent at right angles about 45 inches below it, to bring them into a horizontal poſition, and to convey the wind to the furnace, which is about ſix feet diſtant. The extremities of theſe pipes are fitted into three tuveres of forged iron, fixed at equal diſtances around the circumference of the furnace: theſe three pipes are more or leſs curved or bent, to convey the wind into the furnace by the three apertures made for that purpoſe.

About ſix inches below the box is adjuſted, on each of the three tubes, which deſcend in a vertical direction, a braſs cock about three inches of interior diameter: theſe cocks ſerve to intercept entirely the communication between the bellows and the furnace; and by opening them all more or leſs, or each of them ſeparately, any required quantity of wind may be obtained *.

Theſe cocks are well fixed to the tubes, and kept in their place by two clips of iron ſuited to the diameters of the tubes, and forming a kind of three collars, which by means of four ſcrews embrace and confine them: theſe pieces of iron are themſelves made faſt to two crutches of iron, which ſupport the box and are fixed to it by ſcrews. The box is kept on the crutches by two ſtraps, which embrace it at each extremity, and are fixed by female ſcrews, which are fitted to ſcrews on the ends of theſe ſtraps after they have paſſed through the horizontal part of the two crutches.

To give the proper ſtrength to this furnace, a ſolid ſquare was conſtructed of maſon-work, about a foot larger on each ſide than the exterior diameter of the ſides of the furnace, which were from 21 to 22 inches from outſide to outſide. Bricks were placed on the ground in the middle of this erection for the extent of 18 inches, in order to form a bottom, and on this baſe were placed the ſides of the furnace conſtructed in the manner about to be deſcribed.

I cauſed to be forged two iron hoops ſix lines in thickneſs, from 2 to 2½ inches in breadth, and about 22 inches of exterior diameter: theſe two circles were faſtened together by three bars of iron, the diſtance of their exterior edge being

* Care muſt be taken, when the action of the bellows ceaſes, to ſhut the cocks, eſpecially when coals are uſed in the furnace; for the hydrogen diſengaged from that mineral ſubſtance aſcends into the box and, when the bellows are again made to act, may inflame, and cauſe a violent exploſion, or even burſt the bellows. This accident once took place in the furnace here deſcribed: the box burſt with a loud noiſe on the firſt ſtroke of the bellows, the gas which filled them having ſuddenly inflamed; but by good fortune no perſon was hurt. The ſame thing happened at the houſe of C. Gorlier, locksmith, of Paris: one of his bellows burſt with a horrid exploſion at the moment when they were put in motion.

kept at about nine inches, the height of the bricks: theſe bars are pierced with holes towards the end riveted on the circles, and placed at equal diſtances on their circumference. One of the extremes of each of theſe three bars is left of a ſufficient length to paſs beyond the lower circle about an inch, in order to make them enter into three holes formed in the brick-work which forms the bottom of the furnace, and by theſe means to prevent the furnace from becoming deranged.

This kind of iron frame was filled with bricks ſimilar to thoſe employed for the bottom of the furnace: they were rubbed one on the other to ſmooth them, and the corners were a little rounded; ſo that, being placed upright with their broad ſides applied to the iron hoops, the narrow ſide ſtood inwards. By theſe means all theſe bricks were adjuſted in ſuch a manner as to touch each other by their broadeſt faces, and to form the ſides of the furnace, the thickneſs of which was equal to the breadth of the bricks, and its depth to their length. Three apertures were reſerved for the tuyeres which terminate the three tubes that convey the wind, by cutting from as many bricks a portion equal to the thickneſs of a brick.

Theſe bricks thus adjuſted were taken from the iron frame, and then replaced, putting between them a cement to connect them firmly and to fill up the joints. The duſt produced by cutting the bricks was reſerved for this purpoſe; and I deſired the workman to mix with it a ſmall quantity of clay diluted in a great deal of water, in order to make a puddle for daubing over the bricks, and in particular to put between them no more than was neceſſary for filling the joints and the ſmall ſpace left between their faces in conſequence of any inequality left in dreſſing them.

The furnace thus conſtructed was then placed on its baſe, a ſtratum of the ſame mortar employed for filling up the joinings of the bricks being firſt interpoſed. The extremities of the three iron bars projecting beyond the lower circle were placed in the holes left in the baſe to receive them. The body of the furnace encircled with iron, both by its weight and the gentle blows given to the iron hoops above the bars which connected them, expelled the exceſs of the mortar, and cauſed a part of it to enter and unite with that which filled up the joints of the brick-work of the circumference, which rendered it immoveable.

The bellows is ſecured as uſual by crutches of iron and ſupporters fixed in the wall and to the floor: the handle is diſpoſed in ſuch a manner, that the rope which makes it act

may be pulled by the ſame perſon who manages the fire of the furnace, which in certain caſes is neceſſary.

The tuyeres of forged iron which receive the ends of the copper tubes are ſecured in their proper apertures in the circumference of the furnace by pieces of brick and mortar ſimilar to that employed for filling up the joints; and the ends of the copper pipes introduced into theſe tuyeres are luted with the ſame mortar, a little thickened with brick-duſt.

The aperture of theſe tuyeres towards the interior of the furnace is only nine lines in diameter; on which account, as the volume of air furniſhed by the bellows cannot paſs ſo quick as it is produced, it becomes condenſed in the box placed above the cocks. By theſe means a very uniform blaſt is obtained, which can alſo be regulated by opening more or fewer of the cocks.

During more than ſix years, ſince this furnace was conſtructed, it has ſuffered no derangement: it is not even cracked. It is however worn in the inſide by the violence of the heat it has experienced, which has increaſed its diameter about two inches. The parts round the three tuyeres have alſo got hollowed, ſo that it has need of being repaired. It is intended to make it deeper, and to have a kind of moveable muffs or linings made of fire-clay, in order that its diameter may be reduced at pleaſure: it is meant alſo to conſtruct it in ſuch a manner, as to depoſit the reſt or ſupport for the crucible, not on the bottom of the furnace, but on bars of forged iron placed at the diſtance of ſome inches from that bottom, ſo as to leave below them a vacuity in which the blaſt of the bellows may be diffuſed, and from which it may riſe, paſſing between the bars to traverſe the maſs of charcoal which ſurrounds the crucible. The blaſt will then produce a more uniform fire, and the flame can no longer be directed againſt the ſides of the crucibles; ſo that the riſk of their breaking by ſudden inequalities in the heat will be much leſs.

This alteration is going to be immediately carried into execution, and the method propoſed for doing it is as follows:

A round frame will be made of forged iron, in which bricks will be placed in the ſame manner as above deſcribed. In the lower part of the furnace an aperture will be reſerved for raking out the aſhes, which will be cloſed by means of a door of baked earth carefully luted with clay. Some inches above the bottom of the furnace will be placed a grate of forged iron, and between this grate and the bottom of the furnace the tuyeres will terminate, and the blaſt be introduced. Muffs or linings of very refractory earth will then

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be introduced, ſo as to deſcend to this grate. There will be two of them, one within the other, and both within the body of the furnace. At the lower part theſe muffs will be furniſhed with a rim, projecting outward ſo as to leave between the body of the furnace and the muffs a vacuity, which will be luted at the bottom with clay, and which will be filled with pounded glaſs, or any other ſubſtance a bad conductor of heat.

The interior muff, or both of them, may be removed at pleaſure to obtain a furnace of greater or leſs capacity according to the operations to be performed. It is propoſed to make the muffs wider at the top than at the bottom.

Explanation of the Figures (*Plate I.*).

Fig. 1. Plan of the bellows and of the furnace. A B, the bellows made of wood, the folds of which are alſo of wood covered with leather on the joints. C D, the handle which ſerves for moving the bellows. E, a copper tube which conveys the wind of the bellows into the box F G, in which it is condenſed. F G, a box of wood ſerving as a reſervoir for the wind condenſed by the bellows. H I, K L, M N, three pipes adapted to the box F G, and which convey the wind into the inſide of the furnace by three tuyeres, I, L, N. O P, maſon-work to ſupport the horizontal pipes. Q, the furnace properly ſo called, the form of which is circular, and which is placed on the ſquare maſon-work R, S, T, U.

Fig. 2. Elevation of the furnace, the pipes which convey the blaſt, the cocks, the condenſing box, and the bellows. A B, the bellows mounted in their place, and ſupported by the iron-work neceſſary for ſecuring it, which is fixed in the wall and to the floor. C D, the handle which ſerves for moving the bellows. E, the copper pipe which conveys the blaſt of the bellows to the box F G in which it is condenſed. At G is a hole ſhut by a large cork ſtopper, which can be opened at pleaſure. This box is ſupported by two crutches of iron *f*, *g*, and *h*, *i*, built into the wall, and on which it is fixed by two iron ſtirrups *l*, *m*.

Fig. 3. One of the crutches and its ſtirrup are ſeen repreſented ſidewiſe at *f*, *g*, *l*; the extremities, *n*, *o*, are built into the wall, and the two ends, *p*, *q*, of the iron piece which keeps the box on the horizontal traverſe of the crutch, are tapped, and receive ſcrews which make them faſt to the crutch *f*, *g*. H I, K L, M N, are three pipes which convey the wind into the interior of the furnace. Q, R, S, T, U, maſon-work on which is placed the furnace Q, and which

ſerves

ſerves it as a bottom. OP, maſonry which ſerves to ſupport the three pipes that convey the wind to the furnace. XYZ, fig. 2. are the three cocks fixed to the three pipes which proceed from the box to convey the wind to the furnace.

In fig. 4., the dimenſions of which are double thoſe of fig. 2., may be ſeen the details of one of theſe cocks.

At *r*, *s*, *t*, the body of the cock is ſeen in front; the ſtopper being taken out ſhows at *r* and at *t* the two holes which receive the tubes that communicate either with the box or with the tuyeres. *u* exhibits the body of the cock ſeen on one ſide; *v* the key with its aperture *x*, and its head *y*. This key, turned round more or leſs in its ſocket, ſerves to give more or leſs wind. 1, 2, 3, iron clips which ſecure the cocks at the diſtance they ought to be from each other, and connect them at the ſame time to the iron crutches which ſupport the air-box.

Fig. 5. a plan of theſe two clips. They are bent at the places marked 1, 2, 3, to embrace the body of the three cocks, and ſecure them in ſuch a manner that they cannot be deranged when they are opened or ſhut.

Fig. 6 and 7 repreſent the plane and ſection of the changes and additions propoſed to be made when the furnace is reconſtructed. At I, L, and N, are ſeen the extremities of the three pipes that enter the forged iron tuyeres, and convey the wind to the interior of the furnace. *a*, *b*, and *c*, indicate the thickneſs at the upper part of each of the muffs and of the body of the furnace, between which there are two vacuities filled with pounded glaſs or ſome other bad conductor of heat. *d*, the grate on which are depoſited the reſts of baked earth deſtined to receive the crucibles. *e*, the crucible, luted and attached with clay to a reſt of baked earth.

Note by the Author on the Furnaces which have ſeveral Tuyeres.

The advantage ariſing in large founderies from the application of two or three tuyeres inſtead of one, is well known; but I do not believe that ſuch an arrangement was ever adopted in ſmall furnaces.

At Treibach, in Carinthia, C. Le Febre, and Haſſenfratz member of the council and inſpector of mines, ſaw, about twenty years ago, a large furnace with two tuyeres; drawings of which they brought to France, and which they repreſented in the third plate of *l'Art de fabriquer les Canons*, by Monge: two pairs of bellows ſupply wind through two oppoſite tuyeres, and ſince that arrangement the daily product of metal has been double.

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In England, Mr. Wilkinſon has employed ſeveral years, for fuſing iron ore by coke, furnaces of leſs height than thoſe which he uſed before, and he ſupplies wind by three tuyeres placed at equal diſtances in the circumference of the furnace.

XIII. *On a metallic Solution, which forms a Yellow Ink, that appears and diſappears like that of Hellot. Read before the French National Inſtitute, by* C. GILLET-LAUMONT, *Aſſociate**.

SOME time ago, having thrown into the fire a ſolution of a mixture of ſulphate of copper and muriate of ammonia, where it produced very agreeable colours, ſome of it fell upon a piece of paper placed in the chimney, which became of a bright yellow colour. Having taken the paper from the chimney, I was much aſtoniſhed, ſome moments after, to find that it was no longer coloured: on again expoſing it to heat the colour reappeared, and diſappeared in like manner on cooling.

I tried lately to repeat this experiment; and I obtained from theſe two ſalts, mixed nearly in equal parts, a ſolution of a bright yellow colour when warm, and of a beautiful emerald green when cold, which at firſt gave cryſtals in oblique priſms with rhomboidal baſes, and then blue cryſtals in flat octaedra.

This liquor and the ſolution of the cryſtals gave a yellow ink, which appeared yellow with heat, and diſappeared with cold, but ſtill better with moiſture.

I obſerved that theſe ſolutions are indebted for this property only to the muriate of copper, which when employed alone does not produce the ſame effect.

On comparing this ink with that given by the muriate of cobalt, known under the name of the ſympathetic ink of Hellot, it is ſeen that all theſe kinds of ink are indebted for the property which they have of diſappearing, only to metallic muriates, which powerfully attract the moiſture of ſurrounding bodies.

The yellow ink produced by the muriate of copper and the ſolutions which contain it (very different from thoſe which, being at firſt inviſible, remain fixed after they have appeared) gives by its colour a variety very diſtinct from that of Hellot, which is of a ſea green: with the latter it forms varied tints of an emerald green.

* From the *Journal des Mines*, No. 58.

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They may be made to appear at pleasure by the aid of heat, and to disappear very speedily by putting the writing between the folds of paper somewhat moist: but I must here observe, that it requires much care to make the experiment succeed completely, and that a certain degree of heat must not be exceeded; otherwise, the paper being scorched, the writing can no longer disappear.

XIV. *A short View of the Craniognomic System of Dr.* GALL, *of Vienna. By* L. BOJANUS, *M. D. Member of the Medical Societies of Jena and Paris, and of the Society of the Observers of Man* *.

AT all periods, a desire to find in the exterior of man certain marks indicative of his interior faculties, his passions, his morals, &c., has induced the learned to establish systems of physiognomy more or less satisfactory. The most striking of these systems are those of Baptista Porta and Lavater, the theory of the facial angle, and the system of Dr. Gall.

In regard to the first, who employed himself in comparing the contours of the human figure with those of beasts, observers have determined its value, and consider his principles as the fruit of a disordered imagination, as too bold, too little founded on rational observation, and absolutely uncertain in its application.

The system of Lavater has had more success; but while we revere the genius of that celebrated man, who was truly a great observer, we cannot help acknowledging the instability of the basis on which all the opinions he advances rest; and the mind is not satisfied with truths which can be appreciated only by an imagination equally exalted, and a touch so delicate as that of the author.

The theory of the facial angle, which embraces a wider field than the system of Lavater, leaves us in uncertainty respecting the detail of the faculties, and gives us only general points of view; but it presents us with this truth, of the greatest importance—that the facial angle increases in size in proportion to the faculties of animals: and in this it coincides

* From the *Magazin Encyclopédique*, No. 4, Messidor, an. 10. Dr. Bojanus in a note says: "As this historical explanation is by no means intended to prove the truth of Dr. Gall's system, it can lead to no decisive opinion on this system, which will be established by its author on solid reasoning and convincing testimony. It is necessary also (says he) to observe, that the passages marked with inverted commas do not rest on the authority of Dr. Gall."

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in an evident manner with the general reſults of the ſyſtem of Dr. Gall.

Without entering into an exact detail of the laborious route which this learned philoſopher purſued, to be enabled to eſtabliſh a certain baſis in a ſcience hitherto hypothetical, we ſhall examine briefly his fundamental principles.

1. *The Brain is the material Organ of the internal Faculties.*

Far from attempting to decide the metaphyſical queſtions on the nature of the ſoul, or what may be ſuppoſed as the occult cauſe of the internal faculties, we are, however, forced to admit a material organ for their action.

But, as it is obſerved that theſe faculties are found only where the brain exiſts; that they are loſt with it; that diſeaſe and læſion of the brain have a ſenſible influence on their degree and their action; that the volume of the brain increaſes in direct proportion to the faculties of animals; it is not venturing too far to conſider the brain as the material and intermediate organ.

[It might be here objected, that in ſeveral caſes individuals have loſt a conſiderable portion of the ſubſtance of the brain without the faculties being ſenſibly diminiſhed; but it is to be obſerved that the greater part of the cerebral organs exiſt double, and that the obſervations mentioned are not exact.]

2. *The Brain contains different Organs independent on each other for the different Faculties* *.

The internal faculties do not always exiſt in the ſame proportion to each other. There are ſome men who have a great deal of genius without having a memory, who have courage without circumſpection, and who poſſeſs a metaphyſical ſpirit without being good obſervers.

Beſides, the phænomena of dreaming, of ſomnambuliſm, of delirium, &c. prove to us that the internal faculties do not always act together; that there is often a very great activity of one, while the reſt are not ſenſible.

Thus in old age, and ſometimes in diſeaſe, ſuch, for example, as madneſs, ſeveral faculties are loſt, while others ſubſiſt: beſides, a continued employment of the ſame faculty ſenſibly diminiſhes its energy: if we employ another, we find it has all the force of which it is ſuſceptible; and if we return to the former faculty, it is obſerved that it has reſumed

* This idea of independence ought not to deſtroy that principle of animal organiſm, that all the parts are in a reciprocal ratio: it ought to mark only, that the action of one organ does not abſolutely imply the ſame degree in another.

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its uſual vigour. It is thus that, when fatigued with reading an abſtract philoſophical work, we proceed with pleaſure to a poetical one, and then reſume with the ſame attention our former occupation.

All theſe phænomena prove that the faculties are diſtinct and independent of each other, and we are inclined to believe that the caſe is the ſame with their material organs.

[We do not entirely agree with this idea of Dr. Gall, and we believe, on the contrary, that the ſeparation of the material organs ought to be conſidered as the cauſe of the diſtinction of the internal faculties. It appears, to us at leaſt, that by ſuppoſing the faculties themſelves as originally ſeparated we cannot ſave ourſelves from falling into materialiſm, which exiſts when the mind is no longer conſidered as unity.]

3. *The Expanſion of the Organs contained in the Cranium is in the direct Ratio of the Force of their correſponding Faculties.*

This principle, dictated by analogy, reſts on this axiom, that throughout all nature the faculties are always found to be proportioned to their relative organs; and the truth of it is proved in a ſpecial manner by the particular obſervations of Dr. Gall.

It is however to be remarked, that exerciſe has a great influence on the force of the faculties, and that an organ moderately expanded, but often exerciſed, can give a faculty ſuperior to that which accompanies a very extenſive organ never put in action; as we ſee that a man of a weak conformation acquires, by continued exerciſe, ſtrength ſuperior to another of a more athletic ſtructure.

[We muſt here mention an opinion which ſeems to reſult immediately from this principle, and which, however, is falſe: it is, that the volume of the brain, in general, is in the direct ratio of the energy of its faculties. Obſervation has proved to Dr. Gall, that we cannot judge of the ſtrength of the faculties but by the development of the ſeparate organs which form diſtinct eminences in the cranium; and that a cranium perfectly round, of whatever ſize it may be, is never a proof of many or of great faculties.]

I do not recollect to have heard the reaſon aſſigned by Dr. Gall, but, in my opinion, theſe brains may be conſidered as in a ſtate analogous to obeſity; and as we do not judge of the muſcular force of a man or an animal by the volume of their members, but by the development of the muſcles in particular, I think we ought, in like manner, to judge of the

ſtrength of the faculties by the development of the relative organs.

In the laſt place, the 4th principle, the moſt important for practice in regard to the ſyſtem of Dr. Gall, is:

We may judge of theſe different organs and of their faculties by the exterior form of the cranium.

The truth of this principle is founded upon another, viz. that the conformation of the cranium depends on that of the brain; a truth generally acknowledged, and proved by the anterior part of the brain, by the impreſſions in the anterior part of the cranium, and by other facts.

[There are ſkulls, it is true, in which an external protuberance of the bone correſponds to an interior one; and this irregularity, which is found ſometimes as a diſeaſe, and moſt commonly at an advanced age, when the cerebral organs do not oppoſe the ſame reſiſtance to the cranium, renders the practice of Dr. Gall's ſyſtem, in ſome meaſure, uncertain.]

Guided by theſe principles, Dr. Gall examines the nature of the ſkull, compares the crania of animals and thoſe of men analogous and different in faculties. His reſearches have proved to him, in a manner almoſt inconteſtable, not only the above truths, but that the faculties of animals are analogous to thoſe of man; that what we call inſtinct in animals is found alſo in the latter, ſuch as attachment, cunning, circumſpection, courage, &c.; that the quantity of the organs fixes the difference of the genus of animals, their reciprocal proportion that of individuals; that the diſpoſition originally given to each faculty by nature may be called forth by exerciſe and favourable circumſtances, and ſometimes by diſeaſe, but that it never can be created in the caſe where it has not been given by nature*; that the accumulation of the organs takes place in a conſtant manner from the hind part forwards, from the bottom to the top, in ſuch a manner, that animals in proportion as they approach man in the quantity of their faculties have the ſuperior and anterior part of the brain more expanded; and, in the laſt place, that in the moſt perfect animal, man, there are organs in the anterior and ſuperior parts of the frontal bone, and of the parietals, deſtined for faculties which belong to them excluſively. "It is under the latter point of view that the diſcoveries of Dr. Gall agree perfectly with the theory of the facial angle, which ſeems ſtill further to eſtabliſh the truth of them."

In regard to the details of Dr. Gall's ſyſtem, and the enu-

* The germ of every organ muſt exiſt in embryo, if the expanſion of that organ is to be afterwards called forth.

meration

meration of the different organs which he found, it is difficult to give an exact and satisfactory description of them, when illustrated with the number of facts and examples which he employs to prove, in an evident manner, what he advances; I shall however attempt the enumeration, being persuaded that it will contain several illustrations of the author's manner of considering the subject, and give a true idea of the method to be pursued to attain to his results *.

1. *Organ of the Tenacity of Life.*

The first organ which the author thinks he has found is that of the *tenacity of life* (*tenacitas vitæ*): he considers the medulla oblongata as the seat of it; and as the circumference of the large occipital foramen is in the direct ratio of the extent of the medulla oblongata, he employs the size of this hole to judge of the intensity of the life of an animal.

The observations which serve to support this opinion are, that this hole is generally larger in the crania of women than those of men; that it is constantly large in the cat, the otter, the beaver, the badger, &c., animals well known to have a very tenacious life. Besides, there are no speedier means of killing an animal than to cut the medulla oblongata.

2. *Organ of the Instinct of Self-preservation.*

A little further forward in the medulla oblongata, at the place where it leaves the brain, the author places the *organ of the love of life*, or *of the instinct of self-preservation.*

As animals furnish no instances of suicide, it was only from the human race he could procure examples in favour of this position; and several cases of suicide, in which this part of the brain was diseased, determined him to consider it as the organ of that faculty: he does not, however, consider it as an absolute truth; he waits for further examples to serve as proofs.

3. *Organ for the Choice of Nourishment.*

The organs for the choice of nourishment are found, according to the author, in the quadrigemini tubercles; the anterior of which are larger in carnivorous animals, the posterior more expanded in graminivorous, and which in omnivorous are of equal size.

4. *Cerebral Organs of the external Senses.*

The middle part of the base of the brain is destined to the

* Compare the different articles with the corresponding numbers in the figure, Pl. II.

external senses. This is the region from which the nerves distributed to the organs of these senses proceed.

5. *The Organ of Instinct and Copulation.*

The *organ of instinct and copulation* is situated at the base of the occipital bone, behind the medulla oblongata and the large occipital foramen.

This organ never expands but at the age of puberty, and its increase has a great influence on the form of the nape of the neck, because to this part of the cranium its muscles are affixed.

In animals castrated before the age of puberty, the expansion of this organ does not take place. It is certain that the bull has the chest much broader than the ox, and that "horses subjected to castration before their chest is full have that part always slender."

In the ape, the hare, and cock, this organ is very apparent; and in pigeons and sparrows the occipital forms a particular bag, which seems to be an appendage of the head; and it is well known that these animals are exceedingly ardent in copulation. The same disposition is sometimes found in the cranium of man; and Dr. Gall has in his collection the skulls of several fools, who were distinguished by their lasciviousness, and whose occipital bone presents an enormous projection.

6. *Organ of the reciprocal Love of Parents and Children.*

The organ of the reciprocal love of parents and children occupies the whole posterior and superior part of the occipital: by its position it is intimately connected with the preceding organ, the action of which must necessarily have an influence upon it. "Sometimes its excessive expansion contributes to produce that prolongation of the occipital in the form of a bag, mentioned in the preceding article."

This organ in general is more striking in women than in men, and throughout all nature more so in the female than in the male sex: it is very apparent, in particular, among apes, whose love for their young is so well known that it has become proverbial.

"In general, all animals which show a great deal of attachment to their young are provided with it; and it appears to us that pigeons, the male and female of which both sit on the eggs, and which feed their young by a sort of rumination, may be given as an example."

The cuckow, which never rears its young, is almost entirely destitute of this organ.

7. *Organ*

7. *Organ of Attachment and Friendſhip.*

At the poſterior and middle part of the parietals, and the lateral part of the occipital, is the organ of attachment or friendſhip.

"Its poſition brings it into intimate connection with the two preceding organs, and it appears that theſe organs have an action together, eſpecially in animals deſtined to live in ſociety."

Dogs ſhow the moſt ſurpriſing marks of attachment; and the inſtances are furniſhed chiefly by the barbets, baſſets, and houſe-dogs. Theſe ſpecies, therefore, are diſtinguiſhed by a large head, on which is found the expanſion of this organ behind and above the zygomatic apophyſis. The gre-hound, which is the leaſt ſuſceptible of attachment, has the head narrower behind, and in general is deſtitute of this organ.

8. *Organ of Courage.*

It is the poſterior and inferior angle of the parietal that correſponds to the angle of courage. It contributes to enlarge the ſize of the head, and to ſeparate the ears from each other. Its proximity to the three preceding organs explains to us the fury of animals in rutting-time, and the exceſs of courage in thoſe which have young, or which protect the female and the individuals of their ſociety.

It is very ſtriking in the hyæna, the lion, the wolf, ſome ſpecies of dogs, and particularly in the wild boar, the temerity of which is well known.

On the other hand, the aſs, the gre-hound, the ſheep, and the hare, which are diſtinguiſhed by their timidity, are entirely deſtitute of this organ: their head is ſtraight poſteriorly, and their ears are very near to each other.

A very ſurpriſing phænomenon ſeems to ſupport the opinion of Dr. Gall on the ſeat of this organ: it is a certain involuntary motion of man when he loſes courage. He ſcratches behind his ears, as if deſirous to excite the action of the organ which gives him that faculty.

[We have remarked a movement in cats which appears to have ſome reſemblance to the above, and which relates to the organ of attachment. When fawning on man, they always preſent the poſterior part of the head to rub it againſt him.]

9. *Organ of the Inſtinct to aſſaſſinate.*

Before the organ of courage, towards the middle of the lateral part of the parietals, reſides the organ of the inſtinct to aſſaſſinate.

It appears in all carnivorous animals which live on prey. Dr. Gall found it in the crania of several assassins who had been executed.

10. *Unknown Organs.*

Two organs which correspond to the temporal bone are as yet unknown in regard to their functions.

11. *Organ of Cunning.*

The organ of cunning occupies the anterior and inferior part of the parietals: it appears in all animals distinguished by that faculty; such as the fox, polecat, domestic cat, the diver *, and is in intimate connection with the *organ of theft*, which constitutes a prolongation of it towards the orbit, and which is found in the cat, some dogs, and the magpie.

It is, perhaps, to the development of this organ that we ought to ascribe the great width in the heads of the Calmoucs, among whom a propensity to thieving is a national characteristic.

12. *Organ of Circumspection.*

The organ of circumspection is found in the middle of the parietals, above the organ of cunning and that of the instinct of assassination.

The excessive development of it produces irresolution; want of it, stupidity: it is very striking in the chamois goat, and roe-buck, the circumspection of which is singular, and which never travel on an unknown road without great precaution.

It is found also in animals which do not quit their habitations but in the night-time, such as the owl, otter, &c.

[To be continued.]

XV. *Proceedings of Learned Societies.*

ROYAL ACADEMY OF SCIENCES, BERLIN.

THIS Academy has proposed the following as subjects for

Prize Questions:

I. The Mathematical Class offers a triple prize for the best dissertation on the obliquity of the ecliptic.

Papers on this subject will be received till the 1st of May 1806.

* One observation difficult to be arranged is, that Dr. Gall always found this organ developed in poets: he gives no explanation, but his observation is correct.

II. The

II. The Claſs of the Belles Lettres has again propoſed the queſtion reſpecting the Goths and Gothicism, with the following variations and definitions, and offers a double prize.

1ſt. Did the northern tribes, the Goths, Vandals, Suevi, Longobardi, Franks, Burgundians, Anglo-Saxons, &c., who divided the weſtern poſſeſſions among them, bring with them from their own country any thing peculiar in their arts and ſciences? or, Cannot it be rather proved that every kind of mental culture which theſe people acquired was obtained from their intercourſe with the old inhabitants of the Roman empire, and from their being mixed with them by their conqueſts?

2d. Ought we therefore to aſcribe to theſe people a peculiar ſtyle in their literature and arts? or, Are the ſpecimens of theſe arts which occur in the middle ages only modifications of the antient Greek ſtyle, produced after the decline of the Roman empire by the new political, religious, and moral ſituation of theſe people?

3d. And, if the latter be the caſe, what are the diſtinguiſhing marks of the productions of the middle ages in literature and the fine arts? What is the proper order in which they follow each other? What influence had the cultivation of the fine arts among the Arabs on thoſe of the weſtern part of Europe? When and through what channels was this influence perceptible, and by what ſigns was it diſtinguiſhed?

Papers on this ſubject will be received till the 1ſt of May 1804.

III. The following is the queſtion propoſed by the Phyſical Claſs:—Has electricity any influence on matters in a ſtate of fermentation? Does it contribute to, or impede, fermentation? Does it produce any change in the products of fermentation? What advantage can be derived from calling forth this matter in order to improve the art of preparing wine, beer, vinegar, and brandy?

Papers on this ſubject will be received till the 1ſt of May 1803.

IV. The following is the queſtion propoſed by the Philoſophical Claſs:—Is the moral worth of an action to be taken into conſideration in the application of a criminal law? And if this be the caſe, how far can it be done?

Papers on this ſubject will be received till the 1ſt of May 1803.

ACADEMY OF THE USEFUL SCIENCES, ERFURT.

The queſtion propoſed laſt year, which has not yet been anſwered, is again put by the Academy as

A Prize Queſtion:

What uſeful application can be made in chemiſtry of the temperature below zero of Reaumur's thermometer; and how far is it poſſible, by artificial means, to lower the temperature?

The prize for the beſt anſwer is thirty ducats, and papers will be received till the end of July 1803.

FRENCH NATIONAL INSTITUTE.

Prize Queſtions.

The Claſs of the Moral and Political Sciences has propoſed the following queſtion as the ſubject of a prize:

To determine how the faculty of thinking ought to be decompoſed, and what are its elementary faculties?

The prize will be a gold medal of the weight of five hectogrammes (about 70l. ſterling), and will be decreed in the public ſitting of Germinal, year 12 of the republic. Papers will be received only to the 15th of Nivoſe the ſame year.

The Claſs of the Moral and Political Sciences propoſed in the year 9, as the ſubject for a prize in geography, the following queſtion:

To compare the geographical knowledge of Ptolemy reſpecting the interior of Africa with that which has been tranſmitted to us by later geographers and hiſtorians, except in regard to Egypt and the coaſts of Barbary from Tunis to Morocco?

As the papers tranſmitted to the claſs did not anſwer the conditions, the claſs propoſes the ſame queſtion as the ſubject of a prize for the year 11.

The prize will be a gold medal of the ſame value as the former, and will be adjudged in the public ſitting of Meſſidor, year 12. The period for receiving papers the ſame as above.

In the ſitting of Germinal 15, year 8, the Claſs of the Mathematical and Philoſophical Sciences propoſed as the ſubject of a prize the following queſtion:

To determine, by anatomical and chemical obſervations and experiments, what are the phænomena of the torpor which certain animals, ſuch as the marmot, dormouſe, &c. experience during winter in regard to the circulation of the blood, reſpiration, and irritability; to determine what are the cauſes of this ſleep, and why peculiar to theſe animals.

The

The claſs was of opinion that neither of the two memoirs tranſmitted to it contained a ſufficient illuſtration of the ſubject to be entitled to the prize, but that the obſervations in them were ſufficiently intereſting to deſerve honourable mention. The author of the memoir No. 1, with the motto *Incerta facies inter vitam et mortem*, does not explain the neceſſary diſtinctions between the ways in which the different claſſes of animals ſpend the winter, and does not give ſufficient details in regard to their peculiar habits and the differences in their manner of life. He ſpeaks only of ſome of the mammalia; but he gives anatomical details reſpecting the diaphragmatic nerves, and thoſe known under the name of nerves of the eighth pair, as well as the thymic gland, and the muſcles which ſerve to determine the form which the animal aſſumes during its torpor. He gives alſo ſome curious obſervations on the degree of temperature into which the animal enters when in that ſtate: it was chiefly on the *mus avellanarius*; the bat, *veſpertilio murinus*; the hedge-hog, *erinaceus europæus*; and the marmot, *arctomys marmotta*, that theſe obſervations were made.

One-half of the memoir No. 2, having the motto *Quid mirum ſi non aſcendunt in altum ardua aggreſſi?* is devoted to general obſervations on life and death, and on the different modifications of life. Without conſidering theſe preliminary obſervations foreign to the object which the author propoſes, in our opinion he has given them too much extent. He then makes a diſtinction between animals which paſs the winter in a ſtate of torpor. He ſeparates thoſe whoſe torpor is properly a deep and prolonged ſleep, which he calls *vita ſoporoſa*, from thoſe whoſe torpor is a real ſuſpenſion of the vital functions, which he calls *vita interrupta*. Among the former he examines the bear, *urſus arctos*; the hedge-hog, the bat, the marmot, the dormouſe, *myoxus glis* Schreber.; the wood-rat or muſcardin, *myoxus muſcardinus* Schreber.; and the hamſter, *mus cricetus* Linn. He enlarges a great deal on their habits, their kind of life, and the manner in which they paſs their ſtate of torpor; but gives few details in regard to their anatomy. He however obſerves, as the author of the former, the ſize of the diaphragmatic nerves and the eight triſplanchnic pair, particularly in bats, but does not ſpeak of the ſtate of the thymus. Among animals of the ſecond he diſtinguiſhes thoſe which are provided with organs of circulation, as the amphibia, and thoſe which have no apparent organs of that kind, as is the caſe with inſects; but of the amphibia he examines only frogs, and gives no details reſpecting the torpor of inſects. His obſervations on the frog

are very extenſive: he ſupports them by very curious obſervations on the reſpiration of that animal; the ſtructure of the organs which ſerve for that purpoſe; the properties he aſcribes to the ſkin of theſe animals; the cauſes which make them move during the time of their perfect life, and thoſe which preſerve them during their ſtate of torpor.

We invite the authors to give more extent to thoſe parts of their labour on which they have beſtowed the leaſt care: the talents they have diſplayed in their memoirs do not permit us to doubt that they will fully accompliſh their object.

The claſs again propoſes the ſame ſubject. The prize will be doubled, and will conſiſt of two kilogrammes of gold (about 280l. ſterling). The memoirs muſt be tranſmitted to the ſecretary of the Inſtitute before the 15th of Meſſidor, year 12. The determination of the claſs will be publiſhed in the public ſitting of Vendemiaire, year 13.

GALVANIC SOCIETY, PARIS.

The ſitting of the Galvanic Society at the Oratoire, on the 14th of October, was remarkable both on account of the preſence of the learned men and diſtinguiſhed philoſophers who compoſe it, and of the nature of the experiments made on cold-blooded and warm-blooded animals.

C. Aldini conducted theſe experiments with a great deal of method. The principal ones were as follow:

1ſt. Several frogs recently ſkinned exhibited in ſucceſſion the phænomenon of a very ſenſible contraction without the interpoſition of any metallic ſubſtance, and by the mere contact of the nerves of each with the muſcles.

2d. The animal arc was ſeveral times obtained, and rendered ſenſible by the ſame diſpoſitions as in the preceding experiment.

3d. The phænomenon of ſimultaneous muſcular contraction, in three frogs recently prepared, and placed at the ſide of each other in the ſame direction, was produced at firſt by the aid of ſilver alone. But C. Aldini, being deſirous to prove that the fluid which acted on theſe animals was not metallic electricity, changed the poſition of the intermediate frog by placing the ſuperior extremity of the trunk of the latter parallel to the inferior extremities of the other two. A contraction being then obſerved in the firſt and laſt without producing any effect on that placed in the middle, C. Aldini concluded, that, as the fluid did not purſue the ſhorteſt way of communication, it could not be the electric fluid of metals, one of the general laws of which does not allow it to deviate from the ſhorteſt route.

In another ſeries of experiments the ſame philoſopher exhibited the phænomena of the greateſt excitability reſulting from the application of the Galvanic conductor. 1ſt, Towards the medulla oblongata of the head of a warm-blooded animal recently ſeparated from the trunk. 2d, On the trunk itſelf. 3d, On the head and trunk; at the ſame time making the anus on the one hand, and the ear on the other, communicate with the Galvanic battery. A ſmall quantity of blood ſcattered over the table contributed, no doubt, to the energy of this ſimultaneous contraction of the two parts placed at a remarkable diſtance from each other. 4th, On a portion of the muſcles detached from the body of the ſame animal.

5th. The crural nerve of a frog, brought into contact with one of the muſcles of the warm-blooded animal, exhibited evident ſigns of contraction.

6th. The heart of the ſame warm-blooded animal, placed in a veſſel and ſubjected to the impreſſion of the galvanic battery, gave no ſigns of excitability. This, indeed, is one of thoſe organs which are ſooneſt decompoſed after the death of the individual.

The members of the ſociety paid the utmoſt attention to all theſe experiments; and the preſident, C. Nauche, congratulated in their name C. Aldini on the manner in which he had conducted them, and the zeal he had ſhown to ſupport, by new facts, the theory of his illuſtrious uncle Galvani.

From theſe facts it ſeems to reſult, 1ſt, That the animal fluid ſupplies the place in analogous experiments of the electric fluid propagated by metals. 2d, That this animal fluid has no need of any other conductor than the organized parts. 3d, That the nerves and the muſcles are the ſureſt conductors of this fluid; and, conſequently, that experiments tried either on the nervous plexus or the origin of the nerves muſt preſent the moſt ſtriking and deciſive effects. 4th, That the different metals, in whatever manner applied, in caſes analogous to thoſe in queſtion, perform no other functions than that of favouring, more or leſs, the propagation of this univerſal fluid, which penetrates eaſily, and in preference to all others, the nervous and muſcular parts of organized bodies.

TOURLET.

ACADEMY OF SCIENCES, TURIN.

The Galvanic Committee of this Academy, conſiſting of profeſſors Giulio, Vaſſalli-Eandi, and Roſſi, continue their experiments with great ſucceſs.

C. Giulio will ſoon preſent to the academy two reports on this

this ſubject. In the firſt, after recurring to the experiments which he made in 1792, 1793, and 1794, on ſeveral plants, in order to ſhow how far they were ſenſible to the Galvanic influence by the ſimple medium of *arming* and of metallic arcs, he gives an account of new experiments made lately, in conjunction with Vaſſalli-Eandi, on the different ſpecies of ſenſitive plants, ſuch as the *mimoſa pudica*, the *mimoſa ſenſitiva*, the *mimoſa aſperata*, and the *caſſia ſenſitiva*, which prove that the muſcles of their leaves are ſenſible to the influence of the Galvanic agent called forth by the Voltaic pile.

In the ſecond he gives an account of the reſults obtained by experiments made on a man decapitated, September 18th, in one of the halls of the national college. The principal of theſe reſults were as follow:

1ſt. By making one extremity of the pile communicate with the interior of one ear moiſtened with a ſolution of muriate of ammonia, and the other extremity of the pile with the other ear, very ſtrong contractions were produced in the muſcles of the face: but the contractions of the temporal muſcles, the pterygoid, and maſſeter, were particularly ſtriking, for they elevated and agitated the lower jaw with ſo much force, that the gnaſhing of the teeth was diſtinctly heard at the diſtance of ſeveral feet.

2d. By eſtabliſhing a communication between the ſpinal marrow and the large nervi ſympathetici and vagi armed, and between different regions of the breaſt moiſtened with the ſame ſolution, and the other extremity of the pile—before the cavities were opened very ſtrong tetanic ſhocks were obtained throughout the whole body; ſuch violent palpitations of the heart, that the hand applied on the region of the fifth and ſixth ribs was ſtrongly ſtruck by them; inſpirations and expirations, with a hiſſing noiſe which accompanied the entrance and eſcape of the air.

3d. After opening the breaſt the palpitations of the heart ſtill continued, and could be diſtinctly perceived: when they had ceaſed, they were renewed by eſtabliſhing a communication between the heart and the pile, the large nervi ſympathetici and vagi and the pile.

4th. By arming the abdominal aorta and the plexus cœliacus, and then making them communicate with the pile by means of two reſpective arcs, contractions were produced in the abdominal aorta.

Theſe experiments, added to others announced in a report made to the academy on the 15th of Auguſt laſt, leave no doubt

doubt in regard to the irritable muſcular contractility of the arteries, and of the influence which the nerves have in their action.

5th. By arming the anterior nervous branches of the laſt dorſal nerves and of the thoracic conduit, and eſtabliſhing a communication between that conduit and an extremity of the pile, and the armed nerves and the other extremity, evident contractions were produced in the thoracic canal. Phyſiologiſts know what diſputes have taken place for and againſt the irritable contractility of this canal. The experiments of the Galvanic committee of Turin remove all doubts on the ſubject: in a deciſive manner it preſents, for the firſt time, an irrefragable proof of the irritability of the canal of the chyle, and of the exiſtence of muſcular fibres in the tiſſue of that canal.

6th. One of the eyes was plucked from its orbit, and laid on a plate of glaſs armed with a plate of lead, ſo that the poſterior part of the ball of the eye, the trunk of the optic nerve, and the nervous branches of the lenticular ganglion, were in contact with the plate of lead: a communication was then formed between the plate of lead and one extremity of the pile and the ſclerotica, and between the tranſparent cornea and the other extremity of the ſame pile, by means of exciting arcs.

The ſpectators were greatly aſtoniſhed to ſee the pupil inſtantly contract. An inciſion was made in the cornea; and a fine gold wire being brought into immediate contact with the iris and the laſt filaments of the ciliary nerves, a movement was obſerved in the iris, and a greater contraction in the pupil. There are irritable fibres then in the iris, notwithſtanding what many authors have ſaid to the contrary. But what is the direction of theſe fibres? The profeſſors propoſe to make this a future object of reſearch.

7th. By introducing an arming of lead into the anus, and making it communicate with the pile, while another communication was eſtabliſhed between the ſurface of the inteſtines and the other extremity of the pile, evident contractions were produced in the muſcular tunic of the inteſtines, eſpecially when uncovered by the ſeparation of the exterior membranous tunic, a continuation of the peritoneum.

8th. A long portion of the right anterior muſcle of the leg being extended on a plate of glaſs armed with two plates of lead, the two extremities of the muſcle, when touched by the two ends of the arc, without the intervention of the pile, approached each other, and the nerve immediately became

ſhortened

ſhortened one half. Theſe motions took place even when the arming was removed.

Theſe experiments were made in the preſence of the commiſſary-general of the police, ſeveral profeſſors of the Athenæum, the members of the academy, and a great number of other enlightened citizens.

XVI. *Intelligence and Miſcellaneous Articles.*

VACCINE INOCULATION.

THE following letter, addreſſed by A. van der Velden, ſurgeon and man-midwife at Workendam, to the editor of a Dutch Journal intitled *Algemeene Konſten Letter-Bode* 1802, No. 41, we have tranſlated from that work.

"By the encouragement of ſome friends to humanity, and ſome of our principal medical men, who have exerted themſelves very much to recommend the cow-pock inoculation at this place, about 140 have been inoculated by me and J. Heilijers, ſurgeon and man-midwife at Woudrichem. I am therefore induced to ſend you the following information, with the hopes that it may contribute to the preſervation of thoſe who are ſuffering under the ſmall-pox. In the courſe of the preſent month I was called in by an inhabitant of this place who had the misfortune to loſe two of his children by a confluent ſmall-pox of the moſt malignant ſort, and the third, the only one remaining, was exceedingly ill of the ſame diſorder. Convinced that no injury could ariſe to the patient, I applied the vaccine, being provided with a lancet armed with good matter, and had the happineſs to find, the ſecond day after the vaccination, that the ſymptoms of the ſmall-pox were much mitigated; but on the eighth, and particularly the ninth day after the vaccine inoculation, the puſtules of the natural pox dried up and fell off. In the mean time the vaccine continued to operate, and the following day the child was perceptibly better, and no bad conſequence enſued.

"If you think this ſimple caſe worth inſertion in your Journal, as a further proof of the power and utility of the vaccine, it will give me great pleaſure; eſpecially if it ſhall benefit the public, and excite the attention of others."

ANTIQUITIES.

M. Akerblad, a learned Swede, has opened a new field to the lovers of antiquities, and enlarged the boundaries of our knowledge,

knowledge, by overcoming difficulties ſo great, that the firſt critics of Europe have hitherto conſidered them as unſurmountable. He has immortalized himſelf by a diſcovery which will form an epoch in literature, and has given a ſolution to one of the moſt curious problems in erudition by diſcovering the antient alphabet of the Egyptians, and analyſing it in his *Lettre ſur l'Inſcription Egyptienne de Roſette*, Paris, 8vo. *de l'Imprimerie de la Republique*, year 10.

This intereſting pamphlet is ſold at Paris by Treuttel and Würtz, bookſellers, Quai Voltaire, as well as the following work of M. Akerblad, who ſeems to have been born to unveil the myſteries of the Eaſt: *Inſcriptionis Phenicie Oxonienſis nova Interpretatio*, Pariſiis, an. 10, 8vo. This is a new explanation, much happier than the preceding, of a Phenician inſcription which had exerciſed the ingenuity of the learned Barthelemy and of Simon.

M. Akerblad had before explained, in the Memoirs of the Academy of Göttingen, for 1801, another inſcription which he found in the city of Athens. He explained alſo in the *Magazin Encyclopedique*, *Ventoſe*, year 10, an inſcription in a Coptic manuſcript, which it appeared impoſſible to decypher, becauſe it was written in the running hand of the Copts, till then unknown. It only remains for us to wiſh that M. Akerblad may proceed to London to copy, in the Britiſh Muſeum, and publiſh with his tranſlation, the famous Coptic manuſcript of Dr. Aſkew intitled *Piſtis Sophia*, which would throw great light on the antient philoſophy of the eaſt.

D'Ansse de Villoison,
of the National Inſtitute of France.

The Society of Antiquarians of London have cauſed an accurate delineation to be made of the Greek inſcription, accompanied by two others in honour of Ptolemy-Epiphanes, and found on a ſtone in Egypt, which has ſince been brought to London. This delineation of the Greek inſcription is of the ſame ſize as the original, that is to ſay, 1 foot 3 inches in height, 2 feet in breadth, and containing 54 lines.

A copy tranſmitted to the Royal Society of Göttingen was laid before the members in their ſitting on the 4th of September by profeſſor Heyne, accompanied with a commentary. In the ſame ſitting was laid before the Society of Göttingen, a paper intitled *Prævia de cuneatis quas vocant Inſcriptiones Perſepolitanis legendis et explicandis Relatio*, by G. F. Grotefend, colaborator in the ſchool of Göttingen, who,

who, without being an orientaliſt, has accidentally fallen on the means of explaining this obſcure writing merely by his expertneſs in the art of decyphering. The reſult of his reſearch is, that theſe wedge-like figures are actually characters, and not ſyllables, which proceed from right to left; that the language of theſe inſcriptions is Zendic; and that all the Perſepolitan inſcriptions which he has hitherto been able to explain relate to Darius Hyſtaſpes, and Xerxes.

ASTRONOMY.

1ſt. One of the moſt ſingular phænomena in aſtronomy is, to ſee the ſtar Algol decreaſe in light every three days. I obſerved it very ſenſibly on the 29th of September. It was at 11 hours 15 minutes mean time that its light was the leaſt.

2d The eclipſe of the ſun on the 27th of Auguſt, which I could not ſee at Dijon, was obſerved at Viviers by C. Flaguergues, and at Marſeilles by C. Thulis. The end at Viviers, 18 h. 13 m. 24″; at Marſeilles, 18 h. 11 m. 24″. I thence conclude that the conjunction took place at 19 h. 9 m. 46″ true time at Paris.

3d. C. Pons, keeper of the obſervatory of Marſeilles, has diſcovered a ſecond comet. I ſent him a ſmall preſent. I have requeſted the miniſter to ſend him one more conſiderable, in order to encourage amateurs to ſearch for comets, which are now the great deſideratum in aſtronomy.

4th. I have carefully examined the Egyptian Zodiac which C. Denon has publiſhed. I have obſerved that the ſign Cancer is found in the two lines; it is at the end of the aſcending ſigns and the commencement of the deſcending. This ſeems to indicate clearly that the ſolſtice was in the middle of Cancer. This would go back to 1470 years before the vulgar æra. But I have ſhown in my Aſtronomy, that in the time of Eudoxus, 370 years before the vulgar æra, the Greeks followed this method from ſome antient Egyptian tradition, which they did not correct becauſe they made no obſervations.

5th. The ſmall tables of logarithms juſt publiſhed, being the moſt correct and convenient, the miniſters of the interior and the marine have determined that they ſhall be ſent to all the national ſchools. DELALANDE.

NEW COMET.

In our laſt we announced this diſcovery by C. Mechain on the 28th of Auguſt, at nine in the evening, in the conſtellation of Serpentarius. It was riſing rapidly towards the North pole,

pole, following the right ſide of Serpentarius and the oppoſite ſide of Hercules. It was near enough to be obſerved by the naked eye.

On the 2d of September C. Mechain tranſmitted to the Inſtitute a report on this comet. The elements he aſſigned to it were as follow:

Mean time - - - -	9^{h}	$24'$	$6''$
Right aſcenſion - - -	$249°$	18	
South declination - -	6	11	31.

TANTALITE—A NEW METAL.

A new metallic ſubſtance has lately been diſcovered in Sweden. It was extracted by the celebrated chemiſt Ekeberg from a mineral given to him by M. Geyer. This mineral, found in Finland, had been claſſed among the ores of tin. M. Edelcrantz, of the Academy of Stockholm, tranſmitted a ſpecimen of it to Delametherie, who gives the following deſcription of it. It has a blackiſh colour, with the metallic aſpect of cryſtals of oxidated tin. Its colour is equally dark; its gravity is conſiderable; it ſtrongly ſcratches glaſs. Several facets are diſtinguiſhed in it, but the cryſtal is incomplete. M. Ekeberg has extracted from this mineral a new metallic ſubſtance, to which he gives the name of *Tantalite*. It forms the twenty-third metallic ſubſtance.

SILVER AND IRON.

C. Guyton announced, 25 years ago, that iron and ſilver brought together into perfect fuſion formed two ſeparate buttons adhering by their ſurfaces. He thought he could thence conclude, contrary to the opinion of Gellert, that theſe two metals cannot be alloyed.

The ingenious experiments of Coulomb on magnetiſm having rendered it neceſſary for that philoſopher to procure metals warranted free from iron, C. Guyton propoſed to him to try a button of ſilver from which it appeared that nature itſelf had ſeparated the iron.

The ſilver, indeed, did not contain a quantity of iron which could be rendered ſenſible by chemical re-agents, ſince a ſolution of it did not give an atom of blue with pruſſiate of ſoda. A portion of the ſame fragment exerciſed a ſenſible action on the magnetic bar; and Coulomb, having ſubjected it to his magnetic apparatus, found that it contained a thirtieth of iron.

It then became of importance to examine whether iron did not contain a certain quantity of ſilver. This C. Guyton did with his uſual ability. He aſſured himſelf that in iron there

is an eightieth, or nearly ſo, of ſilver intimately combined; and that this quantity is ſufficient to give it very remarkable properties, ſuch as extraordinary hardneſs, and a fracture which preſents, without continuity, rudiments of cryſtallization.

C. Guyton concludes from theſe experiments on ſilver and iron, as well as from thoſe which he made on iron and lead, that it can no longer be ſaid that theſe metals refuſe to form an alloy, and that there is actually an union in their fuſion; but that by a real quartation the greater part of the two metals ſeparates while cooling in the ratio of their weight, and exactly as copper and lead ſeparate in grand metallurgic operations.

RAPID DISORGANIZATION OF THE HUMAN BODY.

On the night of the 16th of March, 1802, in one of the towns of the State of Maſſachuſetts, the body of an elderly woman evaporated and diſappeared from ſome internal and unknown cauſe, in the duration of about one hour and an half. Part of the family had gone to bed, and the reſt were abroad. The old woman remained awake to take care of the houſe. By and by one of the grand children came home, and diſcovered the floor near the hearth to be on fire. An alarm was made, a light brought, and means taken to extinguiſh it. While theſe things were doing, ſome ſingular appearances were obſerved on the hearth and the contiguous floor. There was a ſort of greaſy ſoot and aſhes, with remains of a human body, and an unuſual ſmell in the room. All the clothes were conſumed; and the grandmother was miſſing. It was at firſt ſuppoſed ſhe had, in attempting to light her pipe of tobacco, fallen into the fire, and been burned to death. But on conſidering how ſmall the fire was, and that ſo total a conſumption could ſcarcely have happened if there had been ten times as much, there is more reaſon to conclude that this is another caſe of that ſpontaneous decompoſition of the human body, of which there are ſeveral inſtances on record. It is to be regretted the particulars have not been more carefully noted.

XVII. *On Painting. By Mr.* E. Dayes, *Painter.*

Essay VI.

On Compoſition or Diſpoſition.

"——————— but in ſuch order all,
As, though hard wrought, may ſeem by chance to fall."
Duke of Buckingham.

COMPOSITION is the forming of a whole by the union of various diſſimilar parts; or, in a more painter-like ſenſe, the art of arranging the figures and other materials of a picture in ſuch a manner that the whole may appear as if the reſult of chance, though produced by the moſt conſummate art.

Before we proceed to offer ſuch rules as are to be extracted from the works of the moſt eſteemed maſters, it may not be improper to premiſe what previous knowledge is neceſſary to enable us to produce a compoſition.

When we have occaſion to ſpeak of the works of certain artiſts, we wiſh at all times to be underſtood as referring *through them to nature*, for it muſt ever be remembered *that art cannot furniſh its own rules.*

Some who have written on the arts have recommended particular books for the uſe of young artiſts; which is ſuppoſing a certain quantity of information ſufficient to make a painter. Where he is to begin his inquiry every one knows; where to ſtop, no one can tell: one thing is certain, there is no danger of too much knowledge making him ſpoil his work.

It is of the firſt importance to imagine well our picture. To this end we muſt take every means to become well acquainted with the hiſtory whence our ſubject is drawn, that we may become familiar with the characters we are to repreſent: hence a reference to their lives becomes neceſſary, that we may not miſtake a bad man for a good one from the ſhow of one good action. This is not all; time and place muſt be attended to, that we may not confound the cuſtoms of one people with the manners of another. The country, alſo, ſhould be characterized by its trees, rivers, monuments, and public buildings, as well as the inhabitants by their dreſs and manners.

All this, nay more, being abſolutely neceſſary, how is it poſſible that an artiſt with a little reading can accompliſh a work like a hiſtorical picture? As well might we ſuppoſe the

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merely reading Homer ſufficient to enable us to deſign from that author without any previous hiſtorical information.

He who firſt acquires a knowledge of geography will not only better underſtand hiſtory and biography, but receive a higher reliſh for them than had he followed a different order of reading. What gives us an intereſt in Æneas, but our ſuppoſing him the founder of the mighty empire of Rome? Otherwiſe, he becomes a mere robber.

As all this knowledge cannot be obtained without much attention, we ſhall find great advantage reſult from making memorandums under their reſpective heads of the cuſtoms, manners, buildings, and other circumſtances connected with hiſtorical painting; by which means we ſhall collect a maſs of information at all times ready to refer to, and that without its interfering in the leaſt with our practical ſtudies. Lord Bacon juſtly obſerves, "The proceeding upon ſomewhat conceived in writing, doth, for the moſt part, facilitate diſpatch; for though it ſhould be wholly rejected, yet that negative is more pregnant of direction than an indefinite, as aſhes are more generative than duſt."

Thoſe who propoſe to themſelves to purſue the great and arduous taſk of hiſtory-painting, ſhould be careful to guard againſt commencing their career too ſoon, or before they have obtained a ſtock ſufficient to that end: ſome have ſtarted with ſo ſlender a capital that it has been confined to colour, *chiaro-ſcuro*, with, now and then, a ſucceſsful compoſition; requiſites that do not ſink below the ſuperficies.

The acquirements neceſſary to qualify an artiſt to purſue the great and important part of the art we are treating of, are many: he ſhould poſſeſs a thorough knowledge of the human figure as far as it regards his art, and its attire, with landſcape, architecture, *chiaro-ſcuro*, and colour: he ſhould be well read in hiſtory, antiquity, and the beſt poets; to which he ſhould join a knowledge of practical geometry, as the foundation of perſpective; with that part of optics called chromatics, as it explains the colours of light and of natural bodies; and, withal, poſſeſs a tolerable facility of hand. Nothing can be more difficult than to fill up the character of a great artiſt, particularly if he propoſes to raiſe a juſt and laſting reputation; and, not content, like the generality of the profeſſion, to produce trifles, extends his views beyond the preſent generation by the cultivation of works that may flouriſh in future ages. To do this, as well as the above acquiſitions he ſhould be endowed by nature with noble and elevated ſentiments; a ready and warm genius to invent, accompanied with the greateſt coolneſs to arrange; penetration

penetration to apply a juſtneſs of character, with patience and induſtry to carry him through the detail: in fact, his nature ſhould be ſo formed as to poſſeſs the contrarieties of hot and cold; that is, with the greateſt vigour ſhould be united the greateſt caution.

O the godlike attribute of extending benefits beyond the grave! Where are now the antient heroes? Their names are ſcarcely remembered, and their miſchiefs have long ceaſed to trouble; while the labours of a Homer, a Virgil, a Shakeſpeare, and Milton, with a long liſt of worthies, give bread at preſent to thouſands!

Some one has well obſerved, "The great end of books is to ſet the mind a-going:" all we can hope from our efforts is, to raiſe in the mind that ſpirit of inquiry that may ultimately lead to an imitation of the great, the noble, or beautiful: all the reſt is froth.

It was their high notions of the art that led the old maſters to ſuch an exalted perfection as to become the admiration of the civilized part of the world, and placed them among the firſt order of mortals, or thoſe who have extended their ſervices beyond their being.

Anger, hatred, and revenge, are paſſions poſſeſſed by every one in common with the brute; but to underſtand that infinitely remote point of perfection which conſtitutes the foundation of true art, is the reward of few.

It is a misfortune for the art, that every one imagines himſelf a critic in painting; all are tried by their peers but the poor painter: but let thoſe who are in affected raptures at the touch of a pencil, or the neatneſs of handling, recollect they are the moſt trifling and inſignificant parts of the art; criticiſm ſhould be general in all great works: it is a common precept in art, that an attention to the whole ſuperſedes all conſideration for the parts *.

> In wit, as nature, what affects our hearts
> Is not the exactneſs of peculiar parts;
> 'Tis not a lip or eye we beauty call,
> But the joint force and full reſult of all.
>
> *Pope's Eſſay on Criticiſm.*

* It muſt not be underſtood that the above precept goes to recommend a neglect of the ſubordinate parts. Over-finiſhing (that is, the nicely defining the form of each part of an object, as a hand, foot, &c.) is not one of the faults of the Britiſh ſchool. This fault, of want of care in making out the parts, is by ſome improperly aſcribed to ſir Joſhua Reynolds. That great man was not without his defects; but we, as rational beings, ſhould avoid them. It would be a poor juſtification for the practice of a vice, becauſe we ſaw it in another. It is much to be doubted, whether the perfections of a great maſter will ever be properly felt by the mere imitator: the reverſe is certain.

Petty criticiſm ſhould be puniſhed with ſilent contempt. We might as well "hew blocks of marble with a razor," or "whiſtle to mile-ſtones," as attempt to convince ſome people. There is an applauſe which is ſuperior to all others, that is, our own, from a conviction of well doing; or, in other words, a conſciouſneſs that our induſtry is rewarded with improvement. He who is too anxiouſly eager for the applauſe of others, exchanges independence for uncertainty, and happineſs for diſappointment. Beſides, he is in danger of falling into a ſtyle familiar and common, ſuch as may beſt ſuit the ideas of ordinary life and vulgar opinion. We muſt be careful not to refine our delicacy to too high a pitch, otherwiſe we ſhall render ourſelves liable to be wounded by every petty criticiſm. Many with whom our ſituation compels us to have an intercourſe are no judges of art; others are influenced by prejudice; many delight to wound: but, whether the obſervation be the reſult of ignorance or vanity, the beſt mode of puniſhment will be neglect.

We have already noticed, under *Invention*, the two characters of compoſition, as the grand and pictureſque; that the former applies to grave and ſerious ſubjects, while the latter appears to aſſociate beſt with gay and ſportive ones. Beauty and grace not only delight in, but derive their greateſt power from, mild variety: hence one of the great beauties in our common writing characters reſults from the ſwell or the oppoſition of force and delicacy in the lines, which give grace independent of form: the ſame thing enriches and adds ſpirit to a maſterly outline, to which if we join fine (we mean true) form, it will poſſeſs the firſt or higheſt kind of excellence. Among the profeſſion there is great difference of opinion relative to compoſition; we ſhould therefore wiſh to be underſtood as offering thoſe rules that relate to matters of taſte with delicacy and modeſty, for fear of forcing genius into one particular track of operation.

Nothing can be more falſe than to ſuppoſe the art of compoſition ſubject to ſome poſitive law, or that the figures of a group ſhould be invariably compoſed under ſome particular form. Men who look to pictures, and from them obtain all their knowledge, are apt to run into this error, and ſuppoſe, becauſe they ſee a group in ſome celebrated picture make ſomewhat of an angle, that all figures to be well put together muſt aſſume the triangle. Others, in contradiction to that doctrine, maintain that the true Venetian method of compoſition requires the group to incline diagonally, that is, running from corner to corner of the picture, aſſerting that the former method is barbarous and French: another ſet of men call

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the horizontal line *ſimplicity*, and the true Roman method, expecting to ſee a range of heads of an equal height running through the greateſt part of the work.

He who wiſhes to affect with ſorrow or melancholy can only expect to ſucceed by the removal of whatever may be likely to pleaſe, either from variety and contraſt of forms, brilliancy of colour, or ſtriking effect of light and ſhade; and one great aid will reſult from telling the ſtory with few figures, which greatly adds to ſimplicity.

The great reaſon why Raphael is preferred for compoſition is his poſſeſſing a ſtyle more ſimple and expreſſive than any other. Simplicity appears to have marked the characters of the Roman and Florentine ſchools, as alſo that of the Caracci; after whom we muſt place Pouſſin, Le Sueur, Bourdon, and ſuch others as have affected the ſame ſimple and expreſſive manner.

Le Brun, though an artiſt of great merit, has, in many inſtances, ſo crowded his compoſition with incidents, that the attention is entirely taken from what ought to conſtitute the principal feature, and the mind becomes diſtracted amidſt a multitude of events: witneſs his Crucifixion, and Slaughter of the Innocents. Expreſſion derives much of its force from ſimplicity. Sterne, in his Sentimental Journey, was obliged to take a ſingle captive to give force to his deſcription. What can more ſtrongly affect our feelings than his Maria? A multitude of objects ruſhing on the ſight deſtroy intereſt, and, in ſingle objects, too many parts produce the ſame effect: hence the neceſſity of not over-crowding with ornaments.

It appears pretty certain that the ſhape of the group muſt depend greatly on the nature of the ſubject. A triumph muſt neceſſarily aſſume a different figure to a ſpectacle like a deſcent from the croſs, becauſe it would be ſo in nature.

Diverſity does not carry with it ſo much art, or the appearance of art, as is generally ſuppoſed; for, if we diligently attend to nature, we ſhall find an infinite variety of formed groups reſulting from the diſpoſition of ſome men to ſit, others to ſtand, the contraſt of children with adults, men on horſeback, the irregularities of ground, and a variety of other circumſtances,—all tending to produce a diverſified and irregular maſs, probably aſſuming, more frequently than any other, a general figure approaching to the pyramid.

If we examine the moſt approved compoſitions of the Roman, Venetian, or other ſchools, we ſhall find not only the general diſpoſition tending to the pyramidal figure, but each group taken ſeparately,—with this difference, that in the Venetian and Flemiſh it is rendered more exceſſive. Hence,

from a dash of excess in Rubens he becomes a better master to study than any other, but he must be studied with caution. The close adhesion of his figures points out the method of composition, the striking and conspicuous manner of arranging his tints evinces the plan pursued in grouping the colours; while the union of shadow with shadow, and light with light, is seen in the breadth and vastness of his masses. By his excess we may learn, as from Diogenes in morals, who observed he acted like musicians, who gave a higher tone in order to indicate a true one.

The affectation of contrast in some artists is abominable; it looks studiously absurd to see a woman lying on the ground with a child at her breast, and another playing near her; besides the common trick of mixing, in *quantum sufficit*, naked with clothed figures; old men with young ones; side opposed to the full face; the contrast of violent motion with languid attitudes; and a thousand other petty arts to trap the unwary. Such violent opposition will never please the judicious. Where the highest degree of the picturesque is intended, it should never be carried to excess. How ridiculous would it appear in a landscape to see trees crossing each other at right angles, or one vertical and another horizontal! In this instance we may take an example from nature, whose progress from season to season is by gentle and almost imperceptible degrees, and not by violent opposition from heat to cold. By the same rule, violent fore-shortenings should be avoided; a little adds dignity, but, in general, the figures had better be composed than otherwise. We should be careful of mistaking bluster and rant for spirit and greatness. "Be not too tame neither, but let your own discretion be your tutor: suit the action to the word, with this special observance, that you overstep not the modesty of nature."

Weak minds are apt, when they attempt the expressive style, to give their figures the wild and extravagant attitudes of lunatics. That grave dignity observable in the works of the Florentine and Roman schools has entitled them to the first place in composition: the next is justly held by the Caracci, whose pupils, as they lost sight of dignity, substituted bustle and show for simple truth. The style of Guercino is forcible and strong, but less elegant and beautiful than Guido, which is easily perceived in the extremities. Poussin has great simplicity in his compositions, though his figures are sometimes too much scattered. He is remarkable for not suffering any low or vulgar thought to break in on the dignity of his story; an error sometimes committed even by Raphael. There are admirable traits of the true Roman

ſimplicity in the pictures of Le Sueur. They are rare jewels; and Le Brun's ſtoning St. Stephen is highly claſſical.

Moſt of the writers on compoſition in painting ſeem to imagine it to depend on contraſt, and recommend it in the ſtrongeſt manner; but violent oppoſition, as before ſtated, not only deſtroys ſimplicity, but is of all affectations the moſt diſguſting. If oppoſition or contraſt were a criterion of excellence, the moſt violent would become the moſt perfect; and, like a caricature, the more unlike nature the better it would be. Variety or contrapoſition is certainly neceſſary; but the degree cannot be aſcertained by weight or meaſure, it muſt be learned from the works of eſteemed maſters. Common ſenſe muſt dictate the neceſſity of not making all the attitudes alike, and alſo keep us from a contrary exceſs.

In a fine compoſition we ſhall diſcover, by an attentive examination, all the parts ſo depending on the whole, that the removal of any object would deſtroy the general good arrangement.

That variety neceſſary to the perfection of a group ſhould be diſplayed in a ſingle figure, eſpecially if it be a beautiful one. If the figure is ſeen in front, its grace will be increaſed by ſhowing the face in profile, with a ſlight inclination in the cheſt *: one of the legs being ſtraight, the other ſhould be thrown back; and ſo of each limb †: but this variety muſt depend on the nature of the ſubject, as ſuch a contraſt would ill become a philoſopher, apoſtle, or ſenator.

A ſingle figure may be conſidered as a group in itſelf, and ſuch a ſtudied one would by no means unite with many, any more than one taken from a number would do as a ſingle figure.

The contraſt obſervable in Raphael is not an affectation of variety, but the reſult of conſummate judgment, where the erect and inactive figure is introduced to give energy and motion to the active. Contraſt in him is the reſult of neceſſity ariſing from deep reflection, not the ſtudied and inſipid oppoſition of an old man, a young woman, a boy and a girl, which we often ſee in pictures. He knew well a philoſopher or an apoſtle would not move like a ſoldier, a virgin like a matron, or children like adults; which appears to make part of that variety obſervable in his works. He

* See Eſſay on Grace in the laſt number of the Philoſophical Magazine, and the plates.

† See the Venus de Medicis, Apollo Belvedere, and others, remarkable for grace.

appears alſo to have preferred the action to its termination; which renders the ſtory more clear, and leaves the ſpectator delighted with a ſuſpended motion, and in expectation of its terminating. A man repreſented in the act of walking, and as having terminated his ſtep, will not have ſo animated an effect as one not having finiſhed it. Much of the beauty of the Apollo Belvedere ariſes from the ſtate of action he is repreſented under. We almoſt imagine he is actually moving when viewed in front.

In a great maſter, every thing is the reſult of reaſon: if a limb, ſuch as a hand or foot, is concealed by drapery, it does not ariſe from idleneſs or ignorance; it is done to give beauty to ſome principal members, by not making too great a diſplay of parts, or to avoid what would otherwiſe produce an ugly form.

The grand or expreſſive ſtyle will ever rank firſt; the other, as in the hands of Lanfranco, Cortona, &c. is only the art of agreeably filling a large picture with figures, or merely pleaſing the eye: it may juſtly be termed *ornamental*, and ranks infinitely below the pure pictureſque. *In all works of art, the philoſopher will inquire whether the head or the hand is moſt employed.* Pouſſin, though admirable in compoſition, often excels in the acceſſary parts. In his Pyrrhus, the figures, and diſtant ground over the river, are more beautiful than the principal part; a prodigality avoided by Raphael; nor is he ſo noble in his beſt thoughts; and his women are often ordinary. We wiſh to be underſtood as always diſtinguiſhing between the grand ſtyle and the picturesque. In the former, the utmoſt ſimplicity is to be obſerved in the arrangement, and every thing like artifice avoided; while the latter admits of, and derives much of its character from, variety.

In a group the artiſt generally prefers unequal numbers, as 3, 5, 7, or 9, which unite with a better grace and afford a greater variety than any other; but, where equal numbers are uſed, thoſe compoſed of two unequal are beſt, as 6, 10, and 14; but double pairs will ill accord, as 4, 8, 12, &c. The principal part of the ſtory ought undoubtedly to occupy the centre of the picture, and the group, by aſſuming a rotund or ſemicircular form, will aſſiſt the light and ſhade, and enable us to bring the principal figure in light, as well as to procure maſſes by combining the ſhadows of ſeveral objects in one. In this reſpect Raphael has diſplayed ſo much judgment, that it appears from his works evident that he would have proved a great maſter in light and ſhade had he been permitted

permitted a longer life: however, he did enough to furniſh the hint to the Venetian ſchool.

In whatever way we may diſpoſe our group, the principal figure ought to be rendered conſpicuous, either from ſituation, colour, drapery, light, or from all theſe combined. To talk about "effect of light and ſhade," and thereby attempt to juſtify an impropriety, would be reducing painting to a ſtyle merely ornamental indeed! and make paintings of no uſe beyond ſtopping a hole in the wall.

As in the drama the hero of the piece has a greater part to ſuſtain to diſtinguiſh him, ſo ours muſt, as it were, lord it over all the other objects.

> Nor paint conſpicuous on the foremoſt plain
> Whate'er is falſe, impertinent, and vain;
> But, like the tragic muſe, thy luſtre throw
> Where the chief action claims its warmeſt glow.
>
> MASON'S FRESNOY.

It muſt not be underſtood that the principal figure ſhould be more laboured or finiſhed; that would deſtroy the unity which ought to prevail through the whole. In forming our groups, the greateſt maſs ought to be in the middle, and the little or ſcattered parts placed on the edges to give the whole a lightneſs; while ſome places require to be left blank for the ſake of repoſe—for, though our picture ſhould be filled, it ſhould not be crowded. As we muſt alſo ſeek to obtain profundity proportioned to the greatneſs of the group, we ſhould, to give the whole a pleaſing air from a variety in its form, avoid placing the figures in a file. Rubens, whoſe art in grouping his figures is great, ſometimes runs into exceſs by attaching them too much together, ſo as to make them appear to cling as inſeparable; but, as before obſerved, his vices teach us what is right. The golden mean muſt form the object of our purſuit, we ſhould avoid a monotony of forms as well as too great a contraſt; a number of extremities following each other in the ſame line will generally produce a bad effect. We ſhould alſo avoid ſhowing them in the ſame point of view. Pouſſin's Sacrament of Baptiſm is an excellent example, where many figures are pointing, all differing from each other.

In exhibiting the naked we are bound to ſhow the moſt beautiful parts, which is, generally ſpeaking, all the joints. The neck and ſhoulders in the male often form a fine maſs in a group. But, above all, we ſhould never conceal the extremities, from the power of expreſſion they diſplay, as well as the room they allow for the ſkill and abilities of the artiſt.

In

In the female, the naked is ever pleaſing, while an artful concealment will augment the beauty and grace.

> But treat the goddeſs like a modeſt fair,
> Nor over-dreſs, nor leave her wholly bare;
> Let not each beauty ev'ry where be ſpy'd,
> Where half the ſkill is decently to hide. POPE.

If our ſtory requires more than one group, the ſame laws muſt influence us in the conduct of each,—they ſhould certainly not exceed three. The principal one ſhould prevail over the others; and, by placing it near the centre, or in the ſecond ſtage of the picture, we ſhall afford the ſpectator a better opportunity of ſeeing it, and alſo furniſh ourſelves a better opportunity of ſurrounding the principal group with the other objects.

As we are bound to ſupport an equilibrium in our compoſition, we ought not to crowd one part of the picture, or leave another too naked; but this muſt be done without adding weight to weight in a horizontal or perpendicular form. The ſame holds of *chiaro-ſcuro* and colour, where maſs muſt ſupport maſs.

The painter, ſpeaking to the eye, ſhould, in the choice of his ſubject, be careful that it admits images ſtriking and grand: it ſhould burſt on the ſpectator like an unexpected peal of thunder. The horſes in the pictures of Rubens add much to the dignity, as do alſo his fine light and ſhade. As in an epic poem, there ſhould be but one action admitted in our picture: it ſhould be an entire, and above all, a great one, and require no further aids to its illuſtration than what is contained in the picture;—it ought to explain the hiſtory, not the hiſtory the painting. As we are not confined to the mere letter of the ſtory, we may uſe any means conſiſtent with probability to illuſtrate our ſubject; as we once ſaw in a drawing of a triumph, where the artiſt, to ſhow the cauſe was love, decorated a car and the ſhields with ſuch objects as were ſymbols of that paſſion; and, further, to ſhow it was connected with Theſeus and the Amazons, in the tablet of an arch repreſented that hero's battle with thoſe heroines: but enough! an ingenious mind will find a thouſand ways of diſplaying itſelf.

Two actions or points of time ſhould never be admitted in one picture. M. Angelo, in the Capella Seſtini, has repreſented Adam and Eve eating the fruit, and expelled the garden, in the ſame piece! Raphael's Peter in priſon, and delivery, can hardly be called one.

It muſt be obvious that the parts of each figure ſhould agree

agree so as to produce a whole: for instance, a thin face should not be united with fat hands. The same unity is necessary between the figure and its attire, which should suit the degree and character of the person as well as be adapted to the age and sex.

We cannot do better than conclude this paper in the words of sir Joshua:—"My advice is this: keep your attention fixed on the higher excellencies. If you compass them and compass nothing more, you are still in the first class. We may regret the innumerable beauties which you may want: you may be imperfect, but still you will be an imperfect person of the highest order." That great man in another place, speaking of "the well-grounded painter, says, "as his pre-eminence depends not upon a trick, he is free from the painful suspicions of a juggler, who lives in perpetual fear lest his trick should be discovered."

XVIII. *Observations on the Zodiac at Dendera. By the Rev.* SAMUEL HENLEY, *F. S. A.**

AS the report of C. Fourrier concerning this zodiac and its high antiquity has made a deep impression on the minds of many, and the argument thence drawn has been deemed of great weight, in opposition to the Mosaic records and revealed religion, I send you the following observations, with the hope that they may reach those who otherwise might not see them, and have their effect upon a large class of readers, who may have too lightly acceded to Fourrier's conclusion.

Denon, speaking of this zodiac as clearly proving the profound knowledge of the antient Egyptians in astronomy, mentions the ruins which contain it, and are extant but twenty minutes ride from Dendera (antiently Tentyra), known at present under the Arabic name of Berbe. Concerning the etymology of this term, various opinions have been offered; but that by the learned De Sacy is most generally admitted. He conjectured it to have been derived from ΠΙ and ΕΡΦΕΙ, *the temple*.

Notwithstanding this conjecture was assented to by Michaelis, Wahl, and Zoega, it has been opposed by Hartmann, who contends that Berba signifies a *pyramid* or *obelisk*. Though supported in this by Schultens, the interpretation rests in part on a conjecture of Reiske, who for Barabi substituted Barami, which, however, in Arabic is plural; and

* Printed, with the author's corrections, from the Monthly Magazine.

on

on the perſuaſion that in Edriſi the deſcription of Berba was more ſuitable to *pyramids* than *temples*. M. de Sacy replies, with conſiderable force, that Schultens would have done more juſtice to Michaelis, if, inſtead of indulging conjecture, he had opened ſome Arabic deſcription of Egypt; for example, Macrizi's, where he would have found inſtances that the term could not ſignify *pyramids*. Accordingly, a paſſage is cited from that author which refers to the very place. "Of the number of Berba is that of Dendera, which is a wonderful edifice. It has 180 windows; each day the ſun enters by one of theſe windows, and on the next by the following, till at length it reaches the laſt, and then returns in a contrary direction." Vanſleb (*Nouvelle Relation en Forme de Journal d'un Voyage fait en Egypte.*) deſcribes Dendera as the ſite of a wonderful temple of the antient Egyptians—*d'une grandeur et d'une hauteur* DEMESURÉE; and viſible at two leagues diſtance. He alſo, applying the account of Macrizi, and conſidering the windows as double, makes them to be as many as there are degrees in the zodiac; ſo that the ſun, riſing each day in a different degree, throws his rays through a different window, till, by thus completing his courſe, he finiſhes that of the year. For this reaſon, it is added, the temple is regarded as *wonderful*.

Taking theſe deſcriptions with the other compartments on the ceilings, given by Denon, one inference, drawn by M. Fourrier, will be readily admitted, which is, that the ſtate of the heavens they exhibit, correſponds with the date of the building. It remains then to determine, from the zodiac in queſtion, what this date was. Denon, on his ſecond viſit, thus deſcribes the temple:—"I went to the ruins, and this time took poſſeſſion of them in the plenitude of repoſe. I was firſt of all delighted to find that my enthuſiaſtic admiration of the great temple was not an illuſion produced by the novelty of its appearance, ſince, after having ſeen all the other Egyptian monuments, this ſtill appeared the moſt perfect in its execution, and conſtructed at *the happieſt period of the arts and ſciences*; EVERY THING IN IT IS *laboured*, is intereſting, is important. It would be neceſſary to draw the whole in its moſt minute detail, to poſſeſs ourſelves of all that is worth carrying away."

The date of 15,000 years before the birth of Chriſt ſeems but ill to agree with this account, when contraſted with the ordinary remains of human efforts, and the uniform effect of human experience. The monuments of remote ages are more remarkable for their rude bulk than elaborate workmanſhip; but, if this be of the time aſſigned, it follows that, in the united

united opinions of Denon and Fourrier, 15,000 years before Chriſt was *the happieſt period of the arts and ſciences*. So much for their joint deciſion!

Taking, however, this calculation independently of the ſtructure itſelf, it is fairly admitted to be accurate, ſo far as it is founded on *equinoctial preceſſions*; but, reſerving diſcuſſions on this head for a work ſhortly to be publiſhed *, it will be ſufficient to obſerve that I had thence fixed the age of this zodiac to the very year and day *before the inſcription aſcertaining them was known*, and which has not, *even yet*, been explained.

The plate given from Denon † repreſents the zodiac in two compartments, as it exiſts on the oppoſite plat-bands of the portico of the temple. The two large figures that embrace the whole, he ſuppoſes, repreſent the year; and the winged emblem before their mouth, eternity, or elſe the paſſage of the ſun to the ſolſtices. The diſk, at the joining of the thighs of the upper figure, he pronounces to be the ſun, whence proceeds a beam of light that falls upon the head of Iſis, which repreſents either the earth or the moon. "The ſun," he continues, "ſituated in the ſign Cancer, may perhaps ſhow the period of the erection of the temple, whilſt the figures joined to the ſigns may mean the fixed ſtars, and thoſe in the boats the revolving bodies, the planets, and the comets." After offering theſe conjectures, this modeſt artiſt, under a conviction of their importance, reſigns to others all further development.

Inſtead of adopting what Denon has conjectured, it will be proper to conſider the zodiac anew. Accordingly, the female form bent over either diviſion, is unqueſtionably the Iſis, which by Horapollo is determined to be *the year*. The winged globe, according to Macrobius, is the ſun commencing his courſe. The veil on the head of the Iſis is that myſterious one which the famous inſcription affirms no mortal had ever withdrawn. On the upper bend or ſhoulder of the lower figure are eight lines or units, denoting that the ſun, at the cardinal points of the year, is in the eighth degree of

* A Diſquiſition on the Date, aſſigned by Fourrier, Commiſſioner of the Sciences and Arts in Egypt, to the antient Zodiac there found: whence the extraordinary Darkneſs recorded by Phlegon, and that by the Hiſtorians of China, in the Reign of Quanivu, are identified with the Darkneſs at our Lord's Crucifixion; the Diſcordance between the Eclipſe noted by Ptolemy, as ſeen at Arbela and Carthage, is accounted for; the further Deſideratum for aſcertaining Longitude, required by the Board at Paris, in their Report on Burg's Tables, ſupplied; and thence, in Reference to the Prophecy of Balaam, the Birth of Chriſt is fixed.

† See Plate IV

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the ſign; for ſo it is ſtated to have been by Manilius at the time of the Julian reform, and ſuch was, according to Columella, the adjuſtment of the Metonic cycle, compared with the tables of Hipparchus. The four ſtars, of eight rays each, are the dog-ſtar, which governed the Egyptian year, and, being eight months viſible in the upper hemiſphere, had a month aſſigned to each ray, as the ſun has twelve rays to deſignate the months of his courſe. Theſe four ſtars here ſignify a quadrennium, when, in the Roman year, an additional, or biſſextile day, was added to the 365 days, which conſtituted the Egyptian. Beneath are twelve other units, as making, in the biſſextile year, the ſolar to exceed the lunar twelve days inſtead of eleven. The little circle, with wings, on the breaſt of Iſis, marks a new but ſubordinate proceſſion of the ſun's courſe, after the quadrennium has been completed. The waving lines extending along the figure are the Egyptian hieroglyphic for flowing water; while the line of ſtars—each marking, by its ſix rays, as many portions of time, and, with the ſquare compriſing them, the ſquare of that number—ſeverally indicates four times ſix hours, or a day. Theſe, amounting to ſeventy-nine, expreſs two months or lunations, and twenty days over, which correſpond to the two lunar months added by Numa to the Roman year; and, with the twelve days allowed as above, compenſate for the difference between the ordinary lunar year and the ſolar biſſextile, while eight days, anſwering to the ſun's advancement in the ſign, complete the given number. From the bend of the leg downward, five days are ſo diſpoſed as to ſhow the five ſupplementary days above twelve months, of thirty days each, that conſtitute the Egyptian year. This is evident from the *hornleſs* beetle annexed, which was, among the Egyptians, an eſtabliſhed hieroglyphic for a month of thirty days. The three ſtars on the band ſurrounding the legs, with the four on the ſhoulder, ſymbolizing conjointly ſeven years, give ſeventy-ſeven days as the difference between lunar and ſolar time, and thus repreſent at once the ſixty-ſeven days which the year, by the reform of Julius, had gone back, with the ten days between the winter ſolſtice and the firſt of January, or ſix days with which he lengthened the months in one part of the year, and four in the other.

Having recourſe to the Iſis of the upper diviſion, it will be found, that, inſtead of eight units on the ſhoulder, ſhe exhibits but ſeven, whereas the laſt of the four ſtars beneath them wants two of its rays, and the units which follow are not twelve but eleven. To account for theſe variations, let it be obſerved, that, before the Julian reform, the Roman year being

being lunar, a month of twenty-two and twenty-three days alternately, named Mercedonius, was inserted after the 23d of February, to adjust the lunar reckoning to solar; but, as in the year of the Julian reform, the twenty-three days were included, there would of course be one day's advance on the calendar computation, which would leave but seven days by the lunar account for the sun's place in the sign; whence the eleven units below would answer to the ordinary differences between the lunar year and the solar; whilst the two rays, deficient in the fourth of the stars, would point out the commencement of the lunar year at Rome on the 1st of March, and the solar of Julius on the 1st of January; or, in other words, would correspond to the augmentation of the year, computed backward, which Numa had made. The stars in squares, as before, designating days, which, to the bend of the leg, amount to sixty-seven, answer to the beginning of the year gone back by the Julian computation, while the seven in addition correspond to the sun's place in the sign, which, with the five supplementary days round the legs, make the twelve days in the last year of lunar intercalation, and, as the four divisions between them show, are coincident again with a quadrennium.

Perfectly congruent with the whole is the pyramidal figure, having a globe or sun at its top. It consists of eleven gradations, which answer to the eleven days between the solar and lunar year, and the ninety-nine divisions upon it discriminate the ninety-nine days from the winter solstice, by which Julius adjusted his reform, to the commencement of the Roman year on the 1st of April. Between, however, the Roman 1st of March and the 1st of April a month was left out, or, in other words, had gone back a sign. This is here expressed by the recess of Cancer from the zodiac, and agrees with Virgil's commencement of the year with Taurus:

> Candidus auratis *aperit* quum cornibus annum
> *Taurus*—

the precise time of which is defined by what immediately follows:

> ———et adverso cedens Canis occidit astro.

If, now, the setting of the dog-star be placed, according to Petau, on the fourth of the kalends of May, and the sixty-seven days which the Roman year had gone back at the Julian reform, thence reckoned, we come to the 26th of February, or 1st of Thoth, at the commencement of the æra of Nabonassar, which was that likewise of the Egyptian year. The changes in the Roman year having varied its form, in respect to its length, as well as the number of its months, and the days

days in them, it had accordingly receded two lunar months, and eight days over, making in the whole ſixty-ſeven, and ſo fell on the 27th of April, or day of the dog-ſtar's ſetting, whence the 28th of March would be the firſt of Aries; but as, according to Hipparchus, compared with Meton and Manilius, Julius Cæſar's year placed the ſun in the eighth day of the ſign, theſe eight days allowed, will fix the beginning of Aries at the vernal equinox, and 21ſt of March.

The anomalies of the Roman year being ſettled by the year of Nabonaſſar, or the Egyptian, it becomes evident, from the pyramidal figure, with the ſun on its ſummit and the cavern beneath, ſignifying the *vacant interlunar cave* of the moon; that the horns of the Pan, ſymbolizing the horizontal beams of the dog-ſtar, or completion of the canicular year, are placed on the common boundary of the eighth and third gradation, or day, in the eleven, which indicate the difference between lunar and ſolar time, or 365 and 354, to diſtinguiſh the eight days for the exceſs beyond the two lunations, and the three other days correſponding to the difference of the Roman lunar year, ending at the 23d of February, and the year of Nabonaſſar beginning on February 26, which was the firſt of Thoth by Egyptian reckoning.

The bandages round the head of the Pan expreſs the ſame, with other notes of diſtinction; for, whilſt the uppermoſt fold has eight points correſponding to eight days, as before, the ſecond exhibits five units, to denote the five Egyptian ſupplementary days, which, with the five points between them, indicate ten days, as correſponding with the winter ſolſtice, December 21, whence Julius commenced his reform, and the 1ſt of January, or his new year's date.

But as, under this reform, the Egyptian year corrected the Roman, ſo the Roman year, thus corrected, was made by Auguſtus the ſtandard of the Egyptian; for, as that conſiſted only of twelve months, of thirty days each, with five days in addition, its commencement receded one day on every quadrennium; conſequently, from the year of Nabonaſſar, and that of the reform of Auguſtus, by Julian reckoning, ſixty-four days twelve hours (the year of Nabonaſſar, which was the Egyptian, beginning at noon, according to the canon of Ptolemy), will ſhow that the firſt of Thoth, five intercedeing days being allowed between the Julian correction, taken as beginning from 707 of Rome, and that of Auguſtus, eſtabliſhed in 725, the biſſextile four days twelve hours (or, reckoned from midnight, five days), had varied from the 21ſt of June, or ſummer ſolſtitial noon, to the 29th of Auguſt, three in the morning, at which time Auguſtus had fixed it:

for sixty-four days twelve hours and four days twelve hours making sixty-nine days, and exceeding the sixty-seven days of Julius by two, Augustus intercalated between the year 709 of Rome, when Julius's reform was completed, and his own, sixteen years after, one day every third year instead of every fourth; and so, instead of four bissextile days, six were inserted. Between three in the morning, when the dog-star rose, and twelve at noon, when the sun was on the meridian, were nine hours to complete the canonical day; these are accordingly expressed by as many lines on the last fold of the bandage winding round the forehead of the Pan.

Having then found, by these discriminations on the zodiac, the opening of the year, from the rise of Taurus, at the setting of the dog-star, which is exemplified by the solar circle in a crescent on the bull's neck, it will be seen that the Thoth thence proceeding is represented as a bull in a boat (for the heavenly bodies, which were the Egyptian divinities, were held to perform their revolutions in this manner), and as it has been seen from the star deprived of two rays on the shoulder of the upper Isis, as well as from the two months difference between the year of Romulus and Numa's, that the sun's place had been altered two signs, the third boat or month proceeds from Gemini to Cancer: accordingly, the foremost figure in it represents a priest taking auguries from the rise of the star, whilst the other is evidently Aquarius, or the overpowering of the Nile, at the apparent new moon of Cancer. But Cancer withdrawing from the zodiac, the overflow falls in with Leo; and here, accordingly, Harpocrates appears as on the day answering to bissextile, which is also intimated to belong to that year by the six leaves on the head of Aquarius, or the Nile. This being suppressed in the Egyptian kalendar, makes Cancer and Leo run into each other, or confounds the last day of one with the other's first. The figure preceding Leo has the star of five rays, which, indicating five months, marks Leo as the fifth sign, whilst the serpent, rising from under his feet, exhibits the Nilotic year thence beginning, as does the serpent behind the Harpocrates, with his head erected from the fourth fold, a quadrennium. The rising and setting dog-star follow, as thus corresponding in respect to fixed and moveable time. From the overflow of the Nile, in the sign Leo, we are brought on to the commencement of the year in Virgo. This is expressed by the torch with two flames, followed by a priest taking auguries at the year's beginning, which the bull's head, whose horns symbolize the apparent new moon, and star of five rays above them, sufficiently evince. This also

does the hawk, or reviviſcence of nature, with a dog's head, and the two units above the ſame ſtar. The two figures with ſtars, to intimate the five months between the riſing and ſetting Dog, introduce Libra. The pedeſtal beneath the ſcale, with the ſun on it, and a ſitting figure, as if watching its ſhadow, under the index of the equinoctial balance, together with the ſun behind, and the other attendant figures, denote the Thoth, or new year's day, beginning from that ſign; whilſt the fourteen articulations in the tail of the dog will be found to agree with the fourteenth year of the ſolar cycle, concurrent with the firſt lunar, when the ſun entered Scorpio. The hieroglyphics next ſucceeding, characterize again the beginning of the year, for ſuch are the hawk, crowned with the lotus; the wolf, ſacred to the ſun; and the ceraſtes, riſing from an oar. The figures of the riſing and ſetting ſtar are intelligible as before. We now come to Sagittarius, an hieroglyphic, compoſed of a human body, with a bifrontal head of a man and a lion; the Nilotic plant, which indicates the overflow, proceeding from the veil under which both are united. The arrow on the bow is the firſt beam of the year, whilſt the cheſt, fore-legs, and body to the wing, belong to Pegaſus, or the horſe of the morning. The hind parts of the wolf complete the reference to the new moon of Thoth, commencing from the dawn. The two diviſions on the wing ſerve to expreſs the diſtinction of the lunar and ſolar difference, which anſwers to the eleven feathers, whilſt the twelve intercalations between the wing and tail of the wolf, on which a raven is ſeated, agree with the obtruſion of the lunar intercalation on the common form of the ſolar year. Over the wolf's tail is a ſtar of five rays, pointing at the diſtance between the moveable and fixed Thoth, whilſt the prieſt, under the maſk of a hawk, the ſymbol of a commencing year, immediately follows, and, with an arrow, or firſt beam of the riſing ſtar, ſtops the further progreſs of the bull, which, to expreſs the *moving* Thoth, has an hind-leg joined to his head. This ſymbol, indeed, with the two next that follow, is a certain key to the whole, inaſmuch as they diſtinctly mark the fixing of the firſt of Thoth, the dog holding the bull's leg by a chain of nine links, ending with the ſtar of five rays as before, whilſt five of theſe ſtars, ſurrounding the Taurine ſymbol, decide their eſtabliſhed import. The one between the horns intimates the original riſe at the firſt of April in the Roman lunar year, at the apparent new moon, that is, the moon on its ſecond day, to which add the intercalary month Mercedonius, and the difference is obtained of the ſun's entrance on the ſign, April 20, which accords

accords with the Roman commencement of the year on the Palilia. Hence, Aries is again found on the 21ſt of March. In perfect congruity with this is the chain of nine links annexed to the ſtar. For, as the ſidereal revolutions in a year, from meridian to meridian, are 366 days, there will conſequently be a day gained by ſidereal reckoning: hence, as the ſun enters capricorn on the 22d of December, at noon, theſe nine days aſcertain the difference between that time and the noon of the 1ſt of January, and thus account for the difference of ten days by the kalendar of Julius when he reformed the Roman year.

Having then found, in this zodiac, the key to the reforms of the Roman year, we have alſo the clue to that of the Egyptian, introduced by Auguſtus in the year of Rome 725, correſponding to the year of Nabonaſſar 720, and making the difference of biſſextiles ſix Egyptian months, or 180 days; but theſe carried back from the 29th of Auguſt, or fixed Thoth, go to the moveable Thoth on the 26th of February. Thus, then, have we the two Thoths, before and behind Capricorn, and theſe 180 days, from the ſun's entrance into Capricorn, with the four biſſextiles between the reform of Julius and Auguſtus, fall in with the ſummer ſolſtice on the 21ſt of June.

But it will be remembered that one of the dog-ſtars on the ſhoulder of Iſis was defective in two rays, and that Numa augmented by two months the Roman year: if, in retroceſſion from Capricorn, theſe two months be cut off, we are ſtopped at the 21ſt of Auguſt, and thence, eight days allowed for the ſun's advance in the ſign, we are brought again to the 29th. To this month Auguſtus gave his name, and Capricorn was his appropriate ſymbol. Suetonius relates of him, that, on conſulting in his youth Theogenes, the mathematician of Apollonia, when the circumſtances of his birth were made known, Theogenes roſe, ſurpriſed, and adored him. The reaſon of this conduct I ſhall elſewhere explain; but here it will be proper to obſerve, that, on the celebrated gem of this emperor's deification, the ſign Capricorn is placed in a circle, with the dog-ſtar behind, which, as five only of its rays can be ſeen, the others ſuppreſſed, will accord with the difference between the 1ſt of January and April, reckoned one way, and, as Auguſtus was born on the 23d of September, adding the difference between lunar and ſolar time (the Roman year being then lunar), to the 1ſt of January in the other. The abſent three rays being thus accounted for, it will be obvious that the remaining five relate to the diſtance between the 23d of September and the 19th of Fe-

bruary, to which the four biſſextile days again included between the Julian and Auguſtan reform, came to the 23d, when the Roman lunar year was intercalated; and again, from the 19th day of February, the eight days in the ſign reach that of the 1ſt of Thoth, the year being biſſextile, and the exceſs of ſidereal days, from noon to noon, allowed.

It remains to obſerve, that, in adjuſting the Roman mode of dating to the Egyptian, there is a nominal difference of three years, which will be found to be but nominal upon comparing the canon of Ptolemy. Hence what, in Roman reckoning after the reform of the kalendar, appears to be the 722d year of the city, contraſted with Egyptian time, will fall into the 725th: now, as Auguſtus was in his thirty-firſt year, when he fixed the 1ſt of Thoth, in the 725th year of Rome, and made this his *firſt* year in Egypt, the two years from that of Antony preceding were conſidered as ſuppreſſed. This the annexed table will ſhow:

Year of Rome from the 21ſt of April.	Æra of Auguſtus at Alexandria, from the fixed new moon of Thoth.	Dates of the Roman Empire from Coins.	Firſt of Thoth fixed to the 29th of Auguſt, and, in biſſextile years, to the 30th. The aſteriſks mark the biſſextile.
722		A	The date commencing from Antony and New Rome.
723	*		Battle of Actium on the 5th of Thoth. Alexandria taken in the month Meſori.
724	1		The death of Cleopatra, and beginning of the Cæſars, afterward ſtyled of Auguſtus, in Egypt
* 725	2	B	The years of Auguſtus began to be ſtricken at Alexandria on coins
726	3	Γ	The beginning of the æra of the Auguſti at Rome, from the kalends of January, A. U. 727.

Thus, then, as Auguſtus is ſtated to have been born in the year of Rome 691, when the Roman year is referred to Egyptian reckoning, it will be ſeen that, in Roman computation, his 31ſt year fell into this year of reform. In perfect conſiſtence with this, and all that has been adduced, is an inſcription on the ſouthern portal of the very temple in which this zodiac exiſts, and which, though hitherto *unapplied*, is given by Denon. It is rendered by Mr. Aikin thus:

"On account of the emperor Cæſar, god, the ſon of Jupiter,

piter, the deliverer, when Publius Octavius being governor, Marcus Claudius Posthumus commander in chief, and Tryphon general, the deputies of the metropolis consecrated, in virtue of the law, the Propylæum to Isis, the greatest of the goddesses, and to the associated gods of the temple, in the 31st year of Cæsar."* Here the inscription breaks off, but, in the Greek, the two words ΘΩΥΘ ΣΕΒΑΣΤΗΙ follow. For these the French translator unaccountably substitutes—*Le College des Prêtres à l'Imperatrice*, whereas it simply signifies *on the sacred Thoth*.

It will now suffice to add, that the nineteen boats under the zodiac exhibit the nineteen years of the Metonic cycle; and to ask, Where *now* are the 15,000 *years before Christ* of the commissioner Fourrier?

XIX. *Memorandums, Hints, Precepts, and Recipes, for the Use of Artists, Manufacturers, and others; including various short Processes either new or little known**.

[Continued from Vol. xi. p. 149.]

Cements for Derbyshire Spar and other Stones.

I. A CEMENT for this purpose may be made with about seven or eight parts of resin and one of bees wax melted together, with a small quantity of plaister of Paris. If it is wished to make the cement fill up the place of any small chips that may have been lost, the quantity of plaister must be increased a little. When the ingredients are well mixed, and the whole is nearly cold, the mass should be well kneaded together. The pieces of spar that are to be joined must be heated until they will melt the cement, and then pressed together, some of the cement being previously interposed.

II. Melted sulphur applied to fragments of stones, previously heated (by placing them before a fire) to at least the melting point of sulphur—and then joined with the sulphur between, makes a pretty firm and durable joining.

Little deficiencies in the stone, as chips out of corners, &c. may also be filled up with melted sulphur in which some of the powder of the stone has been mixed.—Heat the stone first.

* Communications of practical approved recipes and useful hints are requested from our correspondents. We take this opportunity of thanking Messrs. Gill, Pepys, and other friends, for their favours in this way.

Temporary Cements, &c.

Workmen are often at a loſs for ſuch a cement as will hold firmly till they have no further occaſion for it, and yet be eaſily parted when it is neceſſary; as in fixing glaſs plates to blocks to be ground for optical purpoſes, joining metallic plates to be turned in a lathe, &c. For ſuch purpoſes a cement compoſed of the following ingredients will be found to anſwer well:

III. To four ounces of reſin and 1-4th of an ounce of bees wax melted together, add four ounces of whitening (waſhed carbonate of lime or chalk) made previouſly red hot. The whitening ſhould be put in while yet hot, that it may not have time to imbibe moiſture from the atmoſphere. This makes a good cement for holding optical glaſſes on the end of a maundril while grinding, or for ſimilar purpoſes.

To cement plates of metal to the chucks of a lathe in order to turn them, the chuck ſhould be heated, which is commonly done, by directing the flame of a candle upon it urged by a blow-pipe; the metal ſhould alſo be heated in the ſame manner until they will melt the cement applied to them. The pieces, being then placed in contact, are adjuſted centrally while the cement cools, either by holding a pointed ſtick in a ſmall hole previouſly made in the centre of the plate by a prick punch, or by preſſing a piece of wood laterally againſt it. When cold it will be held firm enough, by means of the cement, to bear being turned, and may be diſengaged at any time by again heating it.

IV. Pitch, reſin, and a very ſmall quantity of tallow, melted together, and thickened by ſtirring in dry brick-duſt, is employed by chaſers of gold and ſilver articles to ſupport and hold their work.

This mixture forms a cheap cement uſeful for many purpoſes, as fixing ſmall ſteel articles on the blocks deſtined to hold them for poliſhing, and is much uſed at Birmingham. The proportions of the ingredients depend on the heat of the weather and the particular purpoſe in view. In winter, a larger portion of tallow is neceſſary than in ſummer.

V. Shell-lac is a very ſtrong cement for holding metals, glaſs, or precious ſtones, while cutting, turning, or grinding them. The metal, &c. ſhould be warmed to melt it.

For faſtening ruby cylinders in watches and ſimilar delicate purpoſes, ſhell-lac is alſo very excellent.

Memorandum.—Bees wax mixed with a little colcothar (red oxide of iron) makes a good poliſhing tool for lenſes; uſe

uſe a little finely-waſhed colcothar mixed with water for the cutting material, applied between the tool and the lens.

VI. *White of Eggs*

mixed up with a little quicklime (or a bit of chalk burnt in a common fire and pounded) makes a pretty good cement for glaſs and porcelain. It is not abſolutely neceſſary that the chalk be burnt, though it is generally uſed ſo.

Gum Arabic Cements.

VII. Gum arabic diſſolved in as ſmall a quantity of water as may be, and diluted to a proper conſiſtence with gin or any proof ſpirit, forms a very uſeful cement for all purpoſes where gum water is commonly uſed, the ſpirit preſerving it from becoming putreſcent. As the ſpirit evaporates, more ſhould be added. It ſhould be ſtirred and mixed together at the time of uſing. 2. If plaiſter of Paris be added to gum water, it makes a cement uſeful to ladies in filligree works.

VIII. Gum ammoniac added to the ſolution of gum arabic in proof ſpirits very much improves the cement. It anſwers very well for joining broken glaſs and porcelain articles of ornament.

IX. *A fine tranſparent Glue.*

Shreds or parings of vellum or parchment, boiled for a ſufficient length of time in ſoft water, diſſolve at laſt into a very tranſparent glue. White leather, that is, ſkins dreſſed with alum inſtead of being tanned, will anſwer the ſame end.

Iſinglaſs Cements.

X. A uſeful cement is made of this ſubſtance by either diſſolving it in any proof ſpirit by heat, or by adding to it, when diſſolved in water, an equal quantity of alcohol.

XI. An improved cement may be made by adding to the iſinglaſs, previous to its ſolution in proof ſpirits, one third part of its weight of gum ammoniac. Expoſe the mixture to a boiling heat until the iſinglaſs and gum are diſſolved, and until a drop of the compoſition becomes ſtiff inſtantly as it cools. It will at any future time melt with a degree of heat little exceeding that of the human body, and, in conſequence of ſo ſoon becoming ſtiff on cooling, forms a very valuable cement for many purpoſes, particularly for the very nice and delicate one of fixing on the antennæ, legs, &c. of inſects in cabinets of natural hiſtory.

The eaſy melting of this cement is no objection to its uſe in caſes where the articles themſelves may afterwards be expoſed to moderate heat; for it owes this property only to the

preſence of the alcohol, which evaporates very ſoon after it has been applied.

When uſed to join broken glaſs or china, the pieces to be joined ſhould be previouſly warmed. Immerſion in hot water will give them a ſufficient degree of heat. Wipe off the water before applying the cement, which may be laid on with a pencil: then preſs the pieces together, binding them with a ſtring or a bit of ſoft wire if neceſſary.

XII. *Japaneſe Cement, or Rice Glue.*

This elegant cement is made by mixing rice flour intimately with cold water, and then gently boiling it. It is beautifully white, and dries almoſt tranſparent. Papers paſted together by means of this cement will ſooner ſeparate in their own ſubſtance than at the joining, which makes it extremely uſeful in the preparation of curious paper articles, as tea-trays, ladies' dreſſing boxes, and other articles which require layers of paper to be cemented together. It is in every reſpect preferable to common paſte made with wheat flour for almoſt every purpoſe to which that article is uſually applied. It anſwers well, in particular, for paſting into books the copies of writings taken off by copying machines on unſized ſilver paper.

With this compoſition, made with a comparatively ſmall quantity of water, that it may have a conſiſtence ſimilar to plaſtic clay, models, buſts, ſtatues, baſſo-relievos, and the like, may be formed. When dry, the articles made of it are ſuſceptible of a high poliſh: they are alſo very durable.

The Japaneſe make quadrille-fiſh of this ſubſtance, which ſo nearly reſemble thoſe made of mother-of-pearl, that the officers of our Eaſt Indiamen are often impoſed upon.

XIII. *Glue of the Laplanders.*

The bows of the Laplanders are compoſed of two pieces of wood glued together; one of them of birch, which is flexible, and the other of fir of the marſhes, which is ſtiff, in order that the bow when bent may not break, and that when unbent it may not bend. When theſe two pieces of wood are bent, all the points of contact endeavour to diſunite themſelves, and to prevent this the Laplanders employ the following cement:—They take the ſkins of the largeſt perches *, and, having dried them, moiſten them in cold water until they are ſo ſoft that they may be freed from the ſcales, which they throw away. They then put four or five of theſe ſkins in a rein-deer's bladder, or they wrap them up in the ſoft

* It is probable eel-ſkins would anſwer the ſame purpoſe.—Edit.

bark

bark of the birch-tree in ſuch a manner that water cannot touch them, and place them thus covered into a pot of boiling water, with a ſtone above them to keep them at the bottom. When they have boiled about an hour they take them from the bladder or bark, and they are then found to be ſoft and viſcous. In this ſtate they employ them for glueing together the two pieces of their bows, which they ſtrongly compreſs and tie up until the glue is well dried. Theſe pieces never afterwards ſeparate.—*Tranſactions of the Academy of Sciences at Stockholm.*

XIV. *Jewellers Cement.*

In ſetting precious ſtones, pieces are ſometimes broken off by accident. In ſuch caſes they often join the pieces ſo correctly, that an inexperienced eye cannot diſcover the ſtone to have been broken. They employ for this purpoſe a ſmall piece of gum-maſtic applied between the fragments, which are previouſly heated ſufficiently to enable them to melt the interpoſed gum. They are then preſſed together to force out the redundant quantity of gum.

In the ſame manner cameo heads, but without any ground, made of paſte (white enamel or coloured glaſs) are often cemented on a piece of real ſtone to ſerve them for a ground, producing the appearance of a real onyx, from which they can with difficulty be ſometimes diſtinguiſhed.

Backs are alſo cemented to ſtones in the ſame manner, to change their hue. That is, behind a tranſparent ſtone the colour of which is wiſhed to be altered, a thin plate of a ſtone of a different colour is cemented, which alters the colour of the refracted light to a mixed tint partaking of that of both. In this caſe, the ſurfaces to be joined are previouſly ground as flat and true as poſſible. They are called *dou lets.*

XV. *Turkey Cement for joining Metals, Glaſs, &c.*

The jewellers in Turkey, who are moſtly Armenians, have a curious method of ornamenting watch-caſes, and ſimilar things, with diamonds and other ſtones, by ſimply glueing them on. The ſtone is ſet in ſilver or gold, and the lower part of the metal made flat, or to correſpond with the part to which it is to be fixed; it is then warmed gently, and the glue applied, which is ſo very ſtrong that the parts never ſeparate. This glue, which may be applied to many purpoſes, as it will ſtrongly join bits of glaſs or poliſhed ſteel, is thus made:

Diſſolve five or ſix bits of maſtic, as large as peas, in as much ſpirit of wine as will ſuffice to render it liquid; in another

other veſſel diſſolve as much iſinglaſs (which has been previouſly ſoaken in water till it is ſwollen and ſoft) in French brandy or in rum, as will make two ounces, by meaſure, of ſtrong glue, and add two ſmall bits of gum-galbanum or ammoniacum, which muſt be rubbed or ground till they are diſſolved: then mix the whole with a ſufficient heat; keep it in a phial ſtopt, and when it is to be uſed ſet it in hot water.—*Eton's Survey of the Turkiſh Empire.*

XVI. The proceſs above deſcribed may be ſimplified by adding the gum-ammoniac to the iſinglaſs during its ſolution in proof ſpirit, and expoſing the mixture to a boiling heat until it is diſſolved, when the ſolution of maſtic in alcohol may be added. The gum-ammoniac previouſly diſſolved with the iſinglaſs promotes the union of the maſtic with the mucilage. This cement has been tried in London, and found to anſwer well: it ſtands againſt moiſture.

Cements which reſiſt Moiſture.

Generally ſpeaking, all cements into the compoſition of which gum-lac or maſtic enters, of which we have already given ſome, poſſeſs this property.

XVII. A cement of this kind may be made by diſſolving iſinglaſs in proof ſpirit, to which muſt afterwards be added a ſolution of ſhell-lac in alcohol.

XVIII. Another cement, which will alſo reſiſt moiſture, may be formed by melting by heat, without water, common glue with half its weight of reſin, to which muſt be added ſome red ochre to give it body; it is particularly uſeful for cementing hones to their frames.

XIX. Carpenters employ a cement in framing ſign-boards, &c. to ſtand the weather, which they make by adding to a pint of well made common glue (made with water) an eighth part of that quantity of boiled linſeed oil, dropping it into the glue gently, and ſtirring it all the time.

XX. White lead ground up with boiled linſeed oil to the conſiſtence of paint, makes a good cement for joining broken porcelain, earthen ware, and glaſs articles deſtined to hold water, &c. After the cement is applied, between the pieces they ſhould be preſſed home to each other as cloſe as poſſible. The cloſer the better; nor need any fears be entertained that enough of cement will not be left in the joint; for the thinneſt film that can be interpoſed will hold firmer than a thicker one would. The articles ſhould remain undiſturbed for two or three months, and before uſing them the cement ſticking on the outſide of the joint ſhould be carefully ſcraped off with a knife.

XXI. *A*

XXI. *A Cement that hardens under Water.*

Mr. Gad, in the 32d volume of the Memoirs of the Academy of Stockholm, ſtates, that if clay and calces (oxide) of iron be plentifully mixed with oil, they will form a maſs which will harden even under water.

XXII. *A Glue inſoluble in Water.*

Leather-dreſſers or glovers glue, that of fiſh, and that prepared with linſeed oil, ceruſe, and red lead, which cements pretty ſtrongly glaſs, ſtone, and wood, ſtill leave room to wiſh for one of a ſtronger quality.

An excellent glue may be procured from cheeſe. Take ſkim-milk cheeſe, free it from the rind, cut it in ſlices, and boil it in warm water, ſtirring it with a ſpoon until it be reduced to a ſtrong glue which does not incorporate with water. Then throw away the warm water, pour cold water over the glue, and knead it afterwards in warm water, ſubjecting it to the ſame proceſs ſeveral times. Put the warm glue on a grinding ſtone, and knead it with quicklime until you have a good glue. When you wiſh to uſe this glue you muſt warm it: if it be employed cold it is not ſo ſtrong, but it may alſo be uſed in that manner. This glue is inſoluble in water as ſoon as it is dry, and it becomes ſo in forty-eight hours after it has been applied. It may be uſed for glueing wood, and for cementing marble and broken ſtone, and earthen ware. The joining can ſcarcely be diſcovered.

Baits alſo for catching fiſh may be made of it. Fiſh are very fond of it, and it reſiſts water. Boerhaave obſerved that no menſtruum diſſolved cheeſe, not even aqua-regia.—*Tranſactions of the Academy of Sciences at Stockholm.*

XXIII. *A Cement that will ſtand againſt boiling Water, and even bear a conſiderable Preſſure of Steam.*

In joining the flanches of iron cylinders and other parts of hydraulic and ſteam-engines, great inconvenience is often experienced from the want of a durable cement.

Boiled linſeed oil, litharge, red and white lead, mixed together to a proper conſiſtence, and applied on each ſide of a piece of flannel, previouſly ſhaped to fit the joint, and then interpoſed between the pieces before they are brought home (as the workmen term it) to their place by the ſcrews or other faſtenings employed, make a cloſe and durable joint.

The quantities of the ingredients may be varied without inconvenience, only taking care not to make the maſs too thin with the oil. It is difficult in many caſes inſtantly to make

make a good fitting of large pieces of iron work, which renders it neceſſary ſometimes to join and ſeparate the pieces repeatedly before a proper adjuſtment is obtained. When this is expected, the white lead ought to predominate in the mixture, as it dries much ſlower than the red. A workman, knowing this fact, can be at little loſs in exerciſing his own diſcretion in regulating the quantities. It is ſafeſt to err on the ſide of the white lead, as the durability of the cement is no way injured thereby, only a longer time is required for it to dry and harden.

When the fittings will not admit eaſily of ſo thick a ſubſtance as flannel being interpoſed, linen may be ſubſtituted, or even paper or thin paſteboard; the only reaſon for employing any thing of the kind being the convenience of handling.

This cement anſwers well alſo for joining broken ſtones however large. Ciſterns built of ſquare ſtones, put together with this cement, will never leak or want any repairs. In this caſe the ſtones need not be entirely bedded in it, an inch or even leſs of the edges that are to lie next the water need only be ſo treated: the reſt of the joint may be filled with good lime.

XXIV. *Another Cement that will ſtand the Action of boiling Water and Steam.*

This cement, which is preferable even to the former for ſteam-engines, is prepared as follows:

Take 2 ounces of ſal-ammoniac, 1 ounce of flowers of ſulphur, and 16 ounces of caſt-iron filings or borings. Mix all well together by rubbing them in a mortar, and keep the powder dry.

When the cement is wanted for uſe, take one part of the above powder and twenty parts of clean iron borings or filings, and blend them intimately by grinding them in a mortar. Wet the compound with water, and, when brought to a convenient conſiſtence, apply it to the joints with a wooden or blunt iron ſpatula.

By a play of affinities, which thoſe who are at all acquainted with chemiſtry will be at no loſs to comprehend, a degree of action and reaction takes place among the ingredients, and between them and the iron ſurfaces, which at laſt cauſes the whole to unite as one maſs. In fact, after a time, the mixture and the ſurfaces of the flanches become a ſpecies of pyrites (holding a very large proportion of iron), all the parts of which cohere ſtrongly together.

XXV. *An-*

XXV. *Another Cement of the ſame Kind.*

Take two parts flowers of ſulphur and one part ſal-ammoniac, and mix them together with a little water into a ſtiff paſte.

Take alſo borings or turnings of caſt iron in the ſtate in which they are commonly found in works where boring and turning are carried on, viz. mixed with ſand, and ſift them finely to get rid of the groſſer particles.

When the cement is wanted for uſe, diſſolve a portion of the above paſte in urine, or in water rendered ſlightly acidulous, and to the ſolution add a quantity of the ſifted borings. This mixture, ſpread upon or between flanches of iron pipes, or put into the interſtices of other parts of iron work, will in a little time become as hard as a ſtone.

XXVI. *Blood Cement.*

A cement often uſed by copperſmiths to lay over the rivets and edges of the ſheets of copper in large boilers, to ſerve as an additional ſecurity to the joinings, and to ſecure cocks, &c. from leaking, is made by mixing pounded quicklime with ox's blood. It muſt be applied freſh made, as it ſoon gets ſo hard as to be unfit for uſe.

We believe, if the properties of this cement were duly inveſtigated, it would be found uſeful for many purpoſes to which it has never been yet applied. It is extremely cheap, and very durable.

[To be continued occaſionally.]

XX. *On a new Method of making Cement for Terraces; and the Uſe of liquid Pitch to render them impermeable to Water, and ſecure from the Attacks of Froſt.* By CASIMIR PUYMAURIN.

I SHALL not ſpeak of the nature of the different lime-cements hitherto known, as they have been fully deſcribed by various authors; I ſhall only obſerve, that a cement ought to be hard, ſolid, and impermeable. To obtain a hard and ſolid cement it has been neceſſary to employ different bodies which, by their aggregation with lime, diſſolved in water, ſpeedily abſorb the ſuperabundant moiſture, and furniſh to the particles of lime diffuſed throughout the cement the carbonic acid neceſſary for rendering it ſolid, and regenerating it into calcareous earth.

Vitrified

Vitrified lava, natural and artificial puzzolana, the ſcoriæ of furnaces, pounded bricks, bone-aſhes, have been the baſes of all the cements hitherto made, and they have been obtained more or leſs ſolid. Cements compoſed in this manner have been attended with perfect ſucceſs in the ſouthern parts of Europe, little expoſed to rain: they do not abſorb the exterior moiſture, and the froſt has not power to dilate their pores or to deſtroy their aggregation.

The cements of Italy, Africa, Spain, and other warm countries, unite all thoſe qualities which can be deſired by the moſt exact obſerver; but in our rainy countries, expoſed to very ſtrong froſts, cements ought to poſſeſs a more eſſential quality than hardneſs or ſolidity, that is to ſay, impermeability. Cements compoſed of porous bodies cannot poſſeſs this quality: being hard, and having their greateſt ſolidity during ſummer, the rains of autumn gradually penetrate to their interior parts, to reduce to powder that maſs which a little before had the appearance of the greateſt hardneſs.

The inventors of the moſt celebrated cements have ſeen their experiments fail becauſe they neglected this eſſential quality. The interpoſition of a fat body was long ago employed. Pliny and Vitruvius recommend the thick part of oil, and oil itſelf; but theſe bodies employed alone can never anſwer the intended purpoſe. Oil with the lime of cement forms a ſaponaceous body ſoluble in water: the thick part of oil contains a very large quantity of mucilage, which water diſſolves or carries off.

To preſerve the bottoms of veſſels, and to render them impermeable to water, reſinous bodies have been employed, and particularly liquid pitch. I have thought that my cement ſhould be covered with boiling pitch, as this reſinous body penetrates its pores and renders it impermeable to water. One inconvenience, however, appeared in the uſe of pitch, which is, its property of becoming ſoft during the heat of ſummer. This inconvenience I remedied by beſprinkling the pitch with powder of lime: the lime combines with the pitch, and forms on the cement an exterior ſtratum of new cement reſembling the famous cement of the Romans called *maltha*.

All the merit of my labour conſiſts merely in having firſt employed, for preſerving cements and rendering them impermeable, a fat body capable of penetrating them, of filling up their pores, and of being inſoluble in water.

I ſhall here give the method which I employ for making my cement; but I muſt firſt obſerve, that there cannot be one general method of compoſing cements, unleſs lime-ſtone

and

and ſand were every where of the ſame quality. The obſerver, therefore, muſt examine the nature of the compoſition of the lime he employs, and particularly the purity of the ſand and ſiliceous matters: he may then vary the doſes of the materials of his cement as may be neceſſary.

Every method of making cement requires, in general, that the puzzolana, pounded brick, and ſcoriæ, be reduced to fine powder and ſifted. This precaution is neceſſary for cement which is not to be covered with a reſinous body: its ſurface thereby becomes ſmoother and more compact, and it is leſs liable to be penetrated by moiſture. But this advantage is more than compenſated by the fiſſures and cracks occaſioned by the ſhrinking of the cement. This ſhrinking does not take place in cement made according to my method, becauſe I employ all the matters hard, coarſely pounded, and in fragments of the ſize of a grain of wheat, and often as large as peas. Theſe fragments broken in this manner preſent a great number of angles and cavities into which the calcareous part penetrates, and thus forms a kind of connected chain, which prevents thoſe cracks and fiſſures ſo prejudicial to cement. The lime which I employed was made from hard and white limeſtone of the hill of Cazeres, in the department of the Upper Garonne: this lime diſſolves with a ſort of ebullition and a great heat, and after its ſolution forms a white paſte without any mixture of gravelly parts: it is ſuſceptible of ſwallowing, as the maſons here term it, a great deal of ſand and other hard matters, but it has leſs ſtrength in the open air than meagre lime, which being made from marly ſtone contains in its compoſition a great many baked and vitrified argillaceous matters, which give it great ſtrength when expoſed to the open air and to water. This lime, called in the country *chaux de Bourret*, requires little ſand, becauſe the calcined and vitrified earthy parts which it contains form with it already an intimate mixture, or a kind of cement: this lime, therefore, diſſolved in water, acquires in a little time the hardneſs of ſtone.

The lime I employed then was perfectly pure, without any internal mixture of heterogeneous parts, but which has no great ſolidity when expoſed to the open air.

I found that a fifth part of lime was ſufficient to give to cement that connecting quality neceſſary to envelop all the vitrified and ſiliceous parts of a calcareous ſtratum, and, conſequently, to give it the greateſt ſolidity. Such is the proceſs I employed to form on a roof, conſtructed for two hundred years, the joiſts of which were at a great diſtance from each other, a terrace of forty ſquare fathoms, which ſtill exiſts,

and has withſtood four ſevere winters and our ſcorching ſummers.

One precaution which I did not take, and which embarraſſed me a good deal, was to pound the limeſtone before it was employed. The ſtone diſſolves in water; but ſome ſtones being leſs calcined than others, their nucleus does not diſſolve, and only becomes penetrated with moiſture. When theſe are blended with the gravel and ſiliceous matters employed, at the end of ſome days the cement bliſters and ſplits into ſmall fragments, and bits of the lime which have not been diſſolved are found in the ſtate of lime ſlaked in the open air.

Take two meaſures of river pebbles well waſhed, or fragments of brick of the ſize of a nut; two of tiles and iron ſcales coarſely pounded, one of river ſand perfectly well waſhed, and a meaſure of the lime of Cazeres, juſt from the kiln, and pounded.

Form a circle with the ſand, and throw into the hollow the lime which has been ſlaked, taking care to mix it thoroughly: when the lime is well diluted leave it in that ſtate for three hours in order that the whole lime may be diſſolved; then mix with it gradually the river pebbles, the iron ſcales, the tiles, and the ſand. This mortar muſt then be worked for half an hour, that every ſiliceous ſtone and fragment of tile may be well incorporated *.

Such is the manner in which I prepare cement. There are two methods of employing it; either above a pavement of brick, or below it. The former appears to be the moſt ſolid during the firſt year, while the other ſuffers the rain water to filter through it, but at the end of a certain time it acquires the moſt perfect ſolidity.

As time deſtroys the timber on which the mortar is placed, when a terrace is intended to be made on a floor it muſt be coarſely covered with ſand and clay: when this covering is dry, another, compoſed of mortar and pretty fat ſand, muſt be placed over it: there is no neceſſity for cutting the bricks, and the upper ſurface muſt be rough or notched with a chiſel. This pavement muſt have an inclination ſufficient to make the water run off.

In the month of July, when the two coverings are very dry, the cement compoſed in the above manner muſt be applied in bands of two feet in breadth; two workmen are ſufficient. This ſtratum of cement ought to be from two

* When the cement is almoſt finiſhed throw over it about a buſhel of quicklime in powder. The mortar then becomes very difficult to be ſtirred. Or two pints of milk of lime are then to be added, which will penetrate the cement in every part.

inches

inches and a half to three in thickneſs: the covering on which it is placed ought to be moiſtened with milk of quicklime; and the cement muſt be preſſed down cloſely with the trowel, taking care to beat it with the ſharp edge of that inſtrument. It is ſmoothed by the back of the trowel ſlightly moiſtened. The ſurface of the cement muſt be again preſſed down, to bury the coarſer parts and render the whole ſmooth. When the firſt band is finiſhed the workman proceeds to a ſecond, and the two bands muſt be carefully united to prevent their ſeparation.

This cement ſoon dries, and at the end of an hour can ſuſtain a ſtrong preſſure. It muſt, however, be left ſeven or eight days; after which the ſurface of it is to be ſlightly moiſtened, and then preſſed down and ſmoothed by means of flat ſtones in the ſame manner as marble is poliſhed. This laſt precaution is eſſentially neceſſary, and the ſolidity of the cement will depend on the care with which it has been performed. When the terrace has been conſtructed in this manner, the aggregation of the cement becomes ſtronger, and its pores are ſmaller and leſs numerous.

In order that the cement may ſucceed perfectly, it muſt be made during the great heats of July, that the ſuperabundant water may evaporate, and that it may be perfectly dry before the autumnal rains. At the end of Auguſt, boil pitch, ſuch as that uſed for ſhips, and ſpread it over the cement by means of large bruſhes. As this coating would render the cement not fit to be touched during ſummer, this inconvenience may be remedied in the following manner:—Take lime, ſlaked in the open air and reduced to fine powder, and, having ſprinkled it over the pitch, remove, by means of a broom, the ſuperfluous part of the lime which does not adhere to it. This lime, by combining with the pitch, will form with it a very thin ſtratum of cement ſimilar to the maltha of the Romans. At the beginning of October a ſecond ſtratum of pitch and lime muſt be laid on.

The ſecond method of employing the cement is to place it immediately over the ſtratum of brick and clay, and then to cover it with a pavement of brick, mortar, and ſand. I have two terraces, fifteen fathoms in length and one and a half in breadth, which appear to me to have the greateſt ſolidity. They are not ſo beautiful as thoſe where the cement covers the brick; but they can ſtand every kind of friction or preſſure.

After making a ſtratum of clay and ſand, ſpread over it a ſtratum of cement four inches in thickneſs, well beaten, and

add pebbles fomewhat larger than thofe employed in the preceding cement, and increafe the dofe of lime in proportion: the cement muft then be beaten with clubs like thofe ufed for fmoothing the walks in the neighbourhood of Paris. It is then to be left to dry for a month, after which the furface of it muft be moiftened with milk of lime; and the bricks are to be placed with good lime and-fand.

It is not neceffary that thefe bricks fhould be ground. I have obferved that, by cutting, their ftrength is leffened, as it deftroys their upper half-vitrified furface: nothing then remains below but an earthy furface, which is foon penetrated by moifture, and which is eafily deftroyed by froft. Care muft be taken to fill up the joints with good mortar, which muft be preffed in and fmoothed by the trowel, and then pitched.

Terraces conftructed in this manner fuffer the water for fome time to filter through them in fmall quantity. This water charged with calcareous particles ftops up the pores of the cement; no more filtration takes place: and terraces of this kind have the greateft folidity, and are exceedingly cheap. This cement may be employed with advantage for the interior of apartments; it alfo may fupply the place of pavements of cut bricks, and coft two-thirds lefs.

It muft be fpread over a pavement of rough bricks, or bricks picked with an inftrument, to the thicknefs of an inch or nine lines. The pebbles may be omitted, and their place fupplied by fragments of tiles and iron fcales coarfely pounded: it is then to be preffed down and fmoothed with flat ftones, but before it is painted it muft be fuffered to dry for a month. It is painted and waxed in the fame manner as brick pavement.

Such are the details of the cement I have employed, and which has been attended with complete fuccefs. But I fhall here repeat, that the dofes muft be varied according to the greater or lefs purity of the lime and of the other matters employed; and the application of pitch is merely to prevent the infiltration of water, and the deftruction of the cement by froft.

XXI. *A ſhort View of the Craniognomic Syſtem of Dr.* GALL, *of Vienna. By* L. BOJANUS, *M. D. Member of the Medical Societies of Jena and Paris, and of the Society of the Obſervers of Man.*

[Continued from p. 84.]

13. *Organ of the Inſtinct of exalting oneſelf.*

THE organ in the middle of the interior edge of the parietals at the upper middle part, and a little towards the poſterior of the head, gives us a true idea of the difficulties which oppoſe the reſearches of Dr. Gall, and at the ſame time furniſhes us with a ſtriking example of the happy opinions of this great obſerver.

He found this organ well expanded in the chamois goat, and ſtill more in the bouquetin; he obſerved the ſame thing in ſeveral men diſtinguiſhed for their pride. It was difficult to collect all theſe obſervations into one point of view. But when he conſidered that the chamois goat inhabits the moſt elevated peaks of the mountains; that the bouquetin always endeavours to aſcend higher; and that pride, when attentively examined, is only a deſire of being ſuperior to others; he was perſuaded that it muſt be this organ which produces theſe effects *different in appearance*, and he conſidered it as the organ of the inſtinct of exalting oneſelf.

The head of the proud man, carried upwards and backwards, tends ſtill more to confirm this opinion.

[It appears to us that the picture of the proud man, contraſted with that of the humble and modeſt, renders the truth of this idea ſtill more ſtriking. In the former, every thing is directed upwards: the hair is highly frizzled; the head is elevated; the eye-brows are arched upwards; the eye-lids are raiſed; the ſhoulders are ſtraight; he walks on tip-toe, and looks on every thing around as beneath him. In the latter the hair hangs down naturally; the eye-brows, eye-lids, and head, are lowered, the body and knees are ſlightly bent: in a word, every thing denotes ſubmiſſion, and that he has no wiſh of being above others.]

14. *Organ of the Love of Glory.*

If this organ is more extended on the ſides, it forms that of the love of glory; an inclination very analogous to pride.

15. *Organ of the Love of Truth.*

The function of the organ which ſhows itſelf at the poſterior and ſuperior angle of the parietals is not entirely fixed by

Dr. Gall: he, however, has some reasons for considering this angle as the seat of the organ of the love of truth, but he has not yet collected a sufficient number of facts to be fully convinced of it.

[We find some difficulty in being persuaded that there is any truth in regard to this function ascribed by Dr. Gall to the last-mentioned organ. It appears to us that an organ placed in the middle of those with which animals as well as men are provided, cannot be destined to a faculty such as truth, which belongs only to the latter.

However, the case with this faculty is perhaps the same as with that of pride, which in animals undergoes a great modification: and we confess we have seen two men, one of whom, distinguished by great veracity, was furnished with this organ in the highest degree; whereas the other, who had a most extraordinary propensity to falsehood, was so destitute of it, that his head at that place instead of a cavity exhibited a protuberance.]

In the anterior and inferior part of the frontal bone Dr. Gall has found several organs the function of which is very important.

During his first researches he considered them as the organs of the different kinds of memory; but finding afterwards that they were not only reproductive but also productive, he was induced to consider them as the organs of a particular sense, and to establish on this observation the opinion, that memory in general is only the reproductive action of all the organs: imagination, on the other hand, is their productive action.

The spontaneous movement of the man who endeavours to recollect something, seems to have a relation to these organs. He carries his hand, as if involuntarily, to the base of the forehead. This action, though not perceived by the person who performs it, is however constant, and is never confounded with that already mentioned in speaking of the organ of courage.

16. *Organ of the Sense of Locality.*

The organ of the sense of locality occupies the anterior part of the frontal bone which corresponds to the protuberances above the orbits (*protuberantiæ supra-orbitales*); it generally accompanies those crania which are distinguished by large frontal sinuses, and which always exhibit in the inside a cavity corresponding to an eminence of the brain.

When it acts reproductively it constitutes what we call the memory of locality (*memoria localis*); on the other hand, when

when it acts productively it determines the combinations of new localities.

It is this organ which directs the blood-hound, in which it is very striking: it exists in all the birds of passage: it invites them to change their place of residence; to undertake distant voyages; and to find again their former place of habitation: the stork and swallow are provided with it in an eminent degree, and these are the animals which migrate to the greatest distance from our countries. Men furnished with it are observed to have a strong remembrance of places, and a desire for travelling: it is therefore always found in able landskip painters.

"A general who arranges his army, and who with one look must observe all the localities of the country which it occupies, cannot dispense with this organ." Of this, the great Frederick was a striking example. At an advanced age this organ is one of those which gradually decrease: it is known also that memory of every kind, and imagination, are lost as a man grows old: the frontal sinuses are then increased interiorly; the action of the brain no longer opposes so much resistance to their expansion.

17. *Organ of the Sense of Facts* (Sensus Rerum).

The sense of facts has its corresponding organ in the inferior and anterior part of the frontal bone, in the middle of and below the preceding: it acts productively and reproductively, and in the latter case it supplies a remembrance of facts and of things.

It is an organ very necessary for education and instruction, which absolutely require that one should remember things past: in old age it is subject to the same changes as the preceding.

Among animals the elephant is particularly distinguished by the expansion of this organ. This animal remembers, with the greatest accuracy, every circumstance and fact which has any relation to it.

Among men we have found this organ not only in those who had a great deal of memory in regard to facts and things, but also in those who might be called systematic heads, who arranged facts in order, and deduced conclusions from them; and in those who had a ready conception, and who distinguished themselves by a desire of knowing every thing. It even appears to us that the operation of combining facts to deduce from them a result is one of the principal actions of this organ: the elephant, at least, which keeps in its trunk water to besprinkle, as it passes, the person who offended it

the preceding evening, arranges ſeveral facts, and deduces from them a reſult which is a real logical concluſion; and we are acquainted with no other organ in the elephant to which this action can be referred.

The automatous motion of a man who perceives that he has acted wrong, ſeems to ſupport theſe conjectures: he ſtrikes the middle of the forehead with his hand.

18. *The Organ of Painting and of the Senſe for Colours.*

The organ of the ſenſe for colours or of painting occupies the anterior part of the frontal bone below the orbit. Dr. Gall has obſerved this organ in all painters of great talents.

"As this diſcovery did not reach us till lately, we have been able to collect only a ſmall number of obſervations; we have, however, obſerved it in ſome individuals; and it is very apparent in the head of Raphael, in the National Muſeum, No. 57."

19. *Organ of the Senſe for Numbers.*

The organ which correſponds to the inferior and exterior part of the frontal bone near the zygomatic apophyſis of that bone has the function of the ſenſe of numbers: it exiſts in men who have a retentive memory for numbers, and in arithmeticians, who perform with great facility the combinations of calculation: it exiſts in that kind of pie which has the faculty of counting as far as nine; the only inſtance known among animals.

"We had occaſion to obſerve this organ on the head of a blind perſon at the Quinze-Vingts, who is diſtinguiſhed by his arithmetical talents; and Dr. Gall has in his poſſeſſion the buſts of ſeveral men which furniſh very inſtructive examples."

20. *Organ of the muſical Senſe.*

Below this organ is that of the muſical ſenſe, or ſenſe of ſounds. It acts in the ſame manner as the other organs, productively and reproductively; it gives a memory for recollecting ſounds; it facilitates new combinations of muſical compoſitions; it incites the birds to ſing: it acts in thoſe which are learning to ſpeak, and whoſe language is founded only on this remembrance of ſounds.

It is abſolutely wanting in animals which have no muſical ſenſe; it is very apparent in the parrot and ſtarling; and the great muſicians Gluck, Mozart, Haydn, and Pleyel, furniſh ſtriking examples of it.

21. *Organ of the Senſe for Mechanics.*

In the lateral and inferior part of the frontal bone is placed the organ of the ſenſe for mechanics. The caſtor, which conſtructs

ſtructs edifices, is endowed with it in an eminent degree: it exiſts in the field-mouſe, and in birds which build their neſts with a great deal of art: it is found in men who have a talent the mechanical objects, who conſtruct with eaſe any kind of machine, and who diſtinguiſh themſelves in the different arts that require manual labour. Though it be very difficult to judge of the exiſtence of this organ when it is only moderately expanded, "becauſe the *temporo-maxillary* muſcle covers this part of the cranium, it is very eminent if the faculty exiſts in a ſuperior degree; and it is then one of thoſe organs reſpecting which there can be the leaſt doubt."

22. *Organ of verbal Memory.*

In the interior of the orbit at the bottom of the ſuperior part is the organ of verbal memory; it may be obſerved at the time of its expanſion by the influence it has on the poſition of the globe of the eye, which it always puſhes forwards, and more or leſs without the orbit.

Perſons provided with this organ eaſily retain words in their memory. Dr. Gall, when young, remarked this faculty in ſeveral of his ſchoolfellows, who were not only diſtinguiſhed for this talent, but alſo for very protuberant eyes. This was the firſt obſervation, which afterwards gave a direction to all his reſearches. A great many obſervations in regard to this organ have ſince confirmed the truth of its exiſtence and of its function.

23. *Organ of the Senſe for Languages.*

The organ at the exterior and ſuperior part of the orbit is called by Dr. Gall the organ of the ſenſe for languages. Its preſence has a conſiderable influence on the poſition of the globe of the eye: it forces it downwards and towards the noſe, and increaſes its diſtance from the ſuperior edge of the orbit: in animals it does not exiſt, and therefore in the latter the globe of the eye is directed more towards the exterior and lateral part of the orbit.

Its expanſion is always accompanied with a diſtinguiſhed talent for languages: it is very ſtriking in great philologues; and though it be difficult to judge externally of its exiſtence, we have obſerved that it has never eſcaped the acute eye of Dr. Gall, and that, in regard to this point, he has never once been deceived.

24. *Organ of Memory for Perſons.*

The function of the organ at the upper and interior part of the orbit has not yet been diſcovered by Dr. Gall; but ſeveral

obſervations on man and animals, ſuch as the dog and horſe, have induced him to ſuppoſe it to be the organ of memory for perſons. Its expanſion, like that of the preceding, muſt have an influence on the poſition of the eye; it muſt contribute to remove it from the upper edge of the orbit, and to puſh it towards the exterior and lateral part, if an equal expanſion of the preceding organ does not counterbalance its effect.

25. *Organ of Liberality.*

The organ of liberality is placed in the anterior part of the frontal bone, above thoſe of the ſenſe of locality and of the ſenſe for painting (16 and 18), and cloſe to the muſical ſenſe (20): a very great expanſion of it accompanies prodigality: it is wanting in miſers, and in theſe this part of the frontal bone exhibits a cavity. Dr. Gall has in his poſſeſſion numerous examples of it.

"The proximity of the organ of muſic and of the ſenſe for painting (18 and 2) ſeems often to favour the expanſion of that of liberality; and this, perhaps, is one of the reaſons why we ſo often find prodigals among thoſe men who excel by their talents for theſe two arts."

We conſtantly obſerve, that the older a man grows the more niggardly he becomes: at an advanced age, therefore, the diminution of this organ is ſo ſtriking, that it ſometimes gives riſe to a very conſiderable extenſion of the frontal ſinuses.

26. *Organ of the Spirit of Compariſon.*

The organ above the ſenſe for facts in the middle of the forehead is deſtined for a faculty which Dr. Gall calls the comparative ſpirit (*judicium comparativum*). It forms an oblong eminence, and is found in men who in ſpeaking have a ready command of figures or tropes; who are not at a loſs for expreſſions; who relate well, and have a great deal of loquence.

27. *Organ of the metaphyſical Spirit.*

If this organ is more expanded towards the ſides, ſo that it forms a round eminence which riſes in the middle of the forehead, it indicates a metaphyſical ſpirit. Among the buſts of the antient philoſophers that of Socrates in particular affords one of the moſt ſtriking examples of this organ. Among the modern philoſophers, I ſhall mention only Kant, as one of the moſt celebrated.

[I recollect that the forehead of one of my firſt ſchoolfellows, whom we ſtyled the philoſopher, on account of his attachment

tachment to the abſtract ſciences, exhibited a very ſenſible expanſion of this organ.]

28. *Organ of the Spirit of Obſervation.*

The organ of the ſpirit of obſervation extends over the whole anterior part of the frontal bone, and its expanſion brings the forehead nearer, in a greater or leſs degree, to the vertical line. It is found in particular in the crania of the obſervers of all ages. The celebrated phyſician Frank is endowed with it in an eminent degree; and Dr. Gall himſelf is evidently furniſhed with it.

29. *Organ of the Spirit of Satire.*

The organ of the ſpirit for ſatire and wit (*witz* of the Germans, and *facetiæ* of the French,) correſponds to the frontal protuberances. Dr. Gall obſerved ſeveral examples which prove the truth of this opinion; and we have never found it to fail.

30. *Organ of Mildneſs.*

The organ of mildneſs is ſituated in the middle of the forehead above that of the ſpirit of compariſon (20). It forms that oblong elevation which is conſtantly found in the heads of Chriſt and Mary painted by Raphael and Coreggio, and greatly contributes to give them an engaging character of mildneſs and benevolence: it always accompanies the crania of men naturally mild, and is wanting in thoſe who are malevolent and revengeful *.

Among animals, the roe-buck, hind, pigeon, &c. are provided with it: on the other hand, it is wanting in animals of prey, ſuch as the eagle, ſtarling, tiger, fox, &c. The frontal bone, then, inſtead of being arched and elevated, is depreſſed and hollow.

31. *Organ of Theatrical Talents.*

A very ſtriking enlargement of the ſummit of the frontal bone ariſes from the expanſion of the organ for repreſenting ſentiments by geſtures, or of theatrical talents.

"Dr. Gall has collected many obſervations which prove the truth of this opinion; and it cannot fail to be obſerved by thoſe who examine with attention the heads of the great actors of the different theatres of Paris."

[We think we have obſerved alſo that this organ is particularly expanded in the deaf and dumb; and this we aſcribe to the neceſſity which theſe perſons are under of keeping it in

* That mildneſs which reſults from the principles of morality is not here meant, but that which exiſts by inſtinct, without being the conſequence of moral reflection.

continual action—an exercise which must necessarily favour the improvement of it.]

32. *Organ of Theosophia.*

The organ of theosophia occupies the most elevated part of the frontal bone. All the representations of the old saints preserved to us afford very instructive examples; and if there be one destitute of this character, it is certain that it is also void of expression.

An *excessive* expansion of it is observed in religious fanatics, and in men become religious by superstition. It is the seat of this organ which, according to Dr. Gall, has induced all nations to consider their gods as above them in an elevated place in the heavens. When we consider, indeed, this object with a philosophic eye, there is no more reason for placing the deity above the globe than below it.

33. *Organ of Perseverance.*

The last of the organs hitherto found by Dr. Gall is that of perseverance, constancy, and firmness of character: it is situated at the anterior and superior part of the parietals in the middle of the head. When it exists in excess it gives obstinacy; and inconsistency is the consequence of a want of it.

"In regard to those parts of the cranium in which Dr. Gall has not yet found organs, it is probable that his further researches will some day enable him to discover more; and the work he intends to publish will furnish us with further details on the subject. It belongs therefore to him to convince us, in an incontrovertible manner, of the truth of his system, a detail of which cannot be satisfactory in a treatise so incomplete."

We find it necessary to remark also, that all the organs here enumerated cannot be distinctly perceived but in individuals who possess any faculty in an eminent degree; and that it is impossible to judge properly of a moderate talent, when its organ is too much confounded with the neighbouring ones.

"In regard to the objections made to the system of Dr. Gall, that it *leads immediately to materialism*, we do not see the philosophical reasons on which it is founded. Even if we suppose organs for the interior faculties, the immense distance between thought and matter still remains the same; objects of so heterogeneous a nature are not susceptible of being classed together. Besides, the will still remains entire: it is it which ought to counterbalance the action of the organs; and the passions ought to be restrained by morality.

XXII. *Letter*

XXII. *Letter from Count* MOROZZO *to* C. LACEPEDE, *Senator and Member of the French National Inſtitute, on an Ichneumon brought from Egypt* *.

IN the middle of April 1802, C. Aimet, chef de bataillon in the corps of engineers, brought to Rome a young ichneumon which he had caught in Egypt. I took the earlieſt opportunity of examining it; and, as I made ſome very intereſting obſervations in regard to the natural hiſtory of this animal, I communicate them to you with pleaſure.

The Greeks and the Romans called it the *ichneumon:* it is the *mangouſte* of Buffon, and the *mus Pharaonis* of Proſper Alpinus. It is a pretty animal, about the ſize of a cat, with a long tail; its hair is rough and of conſiderable length; it cannot be compared to any thing better than the briſtles of the wild boar. It is radiated tranſverſely with three colours, viz. grayiſh white, fawn or ruſſet colour, and black. Each hair has five or ſix tranſverſe rings, like the quills of the porcupine: the length of theſe hairs from the body is an inch or an inch and a half; they are ſhorter on the tail, and in particular at the head, which gives to the animal a neat appearance.

The head, and particularly the muzzle, are very ſmall; it has beautiful teeth like thoſe of the dog; two canine, ſix inciſive teeth, and eight grinders in each mandible, making in the whole thirty-two. It has ſmall ears of a brown colour without hair; they adhere to the head like thoſe of apes. Its eyes are ſmall and lively. An obſervation which I made in regard to the eyes will be mentioned hereafter.

Its colour varies a great deal according to the place in which it is viewed. When obſerved towards the ſide of the head it appears to be grayiſh black; when looked at behind, it appears to be reddiſh. The legs, and particularly thoſe before, are ſhort: it has five toes on each foot, four before and one ſmaller behind. The two middle toes on each foot are longer. The nails are black, like thoſe of the dog.

The young ichneumon is very familiar and domeſtic: it is fond of being careſſed; it is much afraid of cold; and though the temperature of Rome is very mild, it was gratified by having a covering now and then thrown over it; ſometimes even a chaffing-diſh was placed near it. Very often it lies down in a round form on a chair or on the bed, which

* From the *Journal de Phyſique, Meſſidor*, an. 10.

it

it leaps upon with great agility, and conceals its head between its thighs to keep itſelf warm.

This individual is a female: it has below its parts of ſex a large bag, which has been deſcribed by all naturaliſts: it is aſſerted that during the great heats it opens this bag in order to cool itſelf. Jonſton gives a very good deſcription of this conduit, which is as follows:—"Meatum denique extra foramen excrementi peramplum, undique pilis cinctus, pudendo muliebri non diſſimilem, quem magno urgenti cætu operiri ſolet. Hinc ſcriptores omnes indiſcriminatim ichneumones et mares et fœminas arbitrati ſunt *." From this conduit an odoriferous liquor diſtills: the individual in queſtion, on the approach of a dog, opens this bag, and the dog immediately retires: no odour however is perceived at the time. The meaſurement of the different parts, which I took from the animal itſelf, is as follows:

	Foot	In.	Lin.
Whole length from the muzzle to the extremity of the tail - - -	2	5	3

It wanted, however, a ſmall bit at the extremity of the tail, which ſeemed to have been cut off, and which may be eſtimated at an inch or an inch and a half †.

Meaſures in Detail.

	Foot.	In.	Lin.
Length of the head - - -	0	4	4
Length of the body - - -	1	2	5
Length of the tail - - -	0	10	6
Total	2	5	3

	Foot.	In	Lin.
Circumference taken at the thickeſt part of the body - - -	1	0	4
Circumference of the muzzle below the eye	0	4	6
Height of the fore-legs - -	0	5	2

The figure given by Buffon is very good, and has a perfect reſemblance to the individual here deſcribed. The figure of Aldrovandi is alſo very correct. The caſe, however, is not the ſame with thoſe of Jonſton and Proſper Alpinus.

In regard to the deſcription which Buffon has given of the mangouſte, it is traced out with the ſame pencil which has ſo well delineated the other animals: he has ſeparated fable

* Jonſton Hiſt. Animal. quad. p. 105.

† Kæmpfer, in the deſcription which he gives of the ichneumon or mangouſte in his *Amœnitates Exoticæ*, p. 574, ſays that it was two feet and a half in length from the head to the extremity of the tail.

from

from hiſtory, and has deſcribed its habits with great propriety. Two obſervations, however, which I had an opportunity of making, and which appear of importance, ſeem to have eſcaped him.

1ſt. That the animal has a kind of interior eye-lid, which paſſes over the globe of the eye as in nocturnal birds; but with this difference, that in the eye of owls this membrane riſes and falls in a direction which I would call perpendicular from the bill to the ſummit of the head, while in the individual in queſtion it proceeds laterally from the noſtrils to the ear; which induces me to believe that the animal ſeeks its prey in the night-time. By means of this interior eye-lid it contracts the pupil at pleaſure, and it muſt then ſee in obſcurity, like the cats; but in the latter the pupil is leſſened and dilated by contraction; whereas in this animal the ſame thing is effected without contraction, and, as we may ſay, by mechanical means.

2d. That the four toes of the fore- as well as hind-feet are connected to each other by a brown membrane without hair, ſuch as that of amphibious animals. I extended its toes and examined this membrane, which is folded backwards, ſo that when the animal walks it is not ſeen. This certainly indicates that the animal ſwims with great facility.

This character proves that it ought to be claſſed among amphibious animals. Jonſton ſays of the ichneumon:—"Amphibium eſt animal et ad Niloticas ripas commoratur." Aldrovandi alſo conſiders it as amphibious: his words are: "Ab ordinis ratione non eſſe alienum opinamur, ſi poſt lutram ichneumonis hiſtoriam recenſeamus, quoniam et ipſe inter animalia αμφοιεριζαντα, id eſt promiſcua in aquis et terrâ degentia, reponamur, ideoque a nonnullis lutra Ægypti nuncupatur*." He quotes alſo Strabo, who is of the ſame opinion. "Strabo quoque hanc belluam aquatilem conſiſtere videtur."

However, though theſe reſpectable authors have conſidered this animal as amphibious †, none of them have mentioned the ſkin on its feet, which forms a kind of fins. Ariſtotle, Pliny, and Proſper Alpinus, are equally ſilent reſpecting it. Though this character ſeems very eſſential in the deſcription of an animal which frequents the banks of rivers; while, on the other hand, they have carefully noticed this peculiarity in the feet of the otter and in thoſe of the caſtor. After what

* Aldrovandi de quad. dig. p. 298.

† I take the word *amphibious* in the ſame ſenſe in which it was taken by the antients; for this term, ſtrictly ſpeaking, can be applied only to the family of the *phocæ*.

has

has been here ſaid, will it be aſſerted that this is not the caſe? By no means; for there is no oppoſing facts.

Buffon in his deſcription of this animal exclaims againſt nomenclators and generic denominations. I know that ſcience will make little progreſs when people are prejudiced in favour of their ſyſtems; but there are certain characters ſo ſtriking in ſome animals that no error can be committed in claſſing them. He reproaches Linnæus with having made the ichneumon at firſt a badger, then a ferret; yet it certainly belongs to neither of theſe ſpecies.

Had he obſerved that ſkin or ſort of fins which it has on its feet, he would certainly have claſſed it among the amphibious quadrupeds after the caſtors and beavers, which have a ſimilar membrane between their toes. Klein calls it *lutra Ægypti* *; but he does not ſpeak of fins. Beſides, as the ichneumons frequent the banks of the rivers in Egypt, where they ſearch in the ſand for the eggs of the crocodile, of which they are exceedingly fond, or go in queſt of thoſe ſerpents which the Nile leaves among the mud after its inundations, they muſt be obliged to croſs, by ſwimming, ſome arms of the river or ſome canals in order to find their prey. For this reaſon nature has provided them with fins, and the conformation of the eye induces me to believe that they muſt alſo ſearch for their food in the night-time. To this fact I ſhall add the decided taſte which the individual in queſtion has for fiſh, which ſeems to prove that the ichneumon in its wild ſtate eats this food.

As this animal will ſoon be at Paris, you will be enabled to examine it yourſelf, and to verify my obſervations. I have no doubt that others will be brought from Egypt: you can examine whether the peculiarities I have deſcribed be common to all ichneumons, or belong only to ſome families.

If this animal ſhould unfortunately die before it arrives at Paris, for it has ſuffered a great deal by the change of climate, and theſe animals, beſides, do not live to a great age, you will ſee the beautiful picture of it which M. Aimet cauſed to be executed by M. Peter, an excellent artiſt in this department, who has repreſented it with the greateſt exactneſs poſſible. Two figures of it are delineated under two points of view. M. Peter kept it at his houſe for a fortnight, to ſtudy its deportment and attitudes, in order that he might be able to give a correct repreſentation of it.

* De quadrup. p. 66.

XXIII. *Of*

XXIII. *Of the State of Vapour ſubſiſting in the Atmoſphere.* *By* RICHARD KIRWAN, *Eſq. LL.D. F.R.S. and P.R.I.A.* *

VAPOUR or moiſture in the atmoſphere may ſubſiſt in denſe air, or in air highly rarefied: that it is found in the former is well known, and that it may ſubſiſt in the latter appears by the obſervations of Bouguer; for he ſaw clouds three or four hundred toiſes above Chiromboracho, and conſequently at the height of twenty-two thouſand five hundred and twenty-eight Engliſh feet, or 4·3 miles over the level of the ſea; a height at which in the temperature of 32° a barometer would ſtand at 12·7 inches. At ſuch heights, and at much inferior, ſince evaporation proceeds much more quickly, it is not to be ſuppoſed that all the vapour ſo rapidly produced is diſſolved in the ambient air, but part riſes uncombined, as it does under an exhauſted or half-exhauſted receiver, and in this caſe Mr. De Luc's ſyſtem is admiſſible. This emiſſion of pure vapour ſeems to begin at heights at which the denſity of the air is 25, (that is, at heights at which the barometer would ſtand at twenty-five inches, and thus I ſhall in future expreſs the various denſities of air,) at leaſt it is very conſiderable where the denſity is twenty. This leads me to treat of the properties and ſtate of pure inviſible vapour, namely, its ſpecific heat, elaſticity, and ſpecific gravity.

The immortal Doctor Black, the father of all diſcoveries of this kind, informed me that the vapour of water, boiling at 212°, that is, at 180° above the freezing point, and poſſeſſing the ſame ſenſible heat as the water, contains nine hundred and forty times more latent heat than an equal weight of water does heated to 212°, or 5·222 times more latent heat than it does of ſenſible heat, counting from the freezing point, for 180 × 5·222 = 940 nearly. In this caſe the preſſure or denſity of the atmoſphere is thirty, the barometer ſtanding at the height of thirty inches; and with Doctor Black's account the experiments of Mr. Schmidt of Gieſſen very nearly agree; for according to him the latent heat of the vapour of water, barometer 29·84 inches, and the heat 212°, is 5·33 times greater than its ſenſible heat above the freezing point: now 180 × 5·33 = 959·4†. The difference or exceſs in his experiment proceeds from the preſſure of the at-

* From his paper intitled, "Of the Variations of the Atmoſphere," Dublin, 1801.

† Gren's Phyſical Journal, iv. p. 315.

moſphere being ſomewhat lower, as Mr. Watt's experiments prove.

Mr. Watt diſcovered that the latent heat of ſteam diminiſhed in proportion as its ſenſible heat increaſed, Phil. Tranſ. 1784, p. 355. Now the ſenſible heat of ſteam exceeds 180° above the freezing point when the barometer ſtands above thirty inches, and leſs than 180° when the barometer ſtands lower than thirty inches, as Mr. De Luc firſt diſcovered, and may be ſeen in Sir George Schuckburgh's and Mr. De Luc's tables, Phil. Tranſ. 779, p. 375. From theſe I have deduced the following table:

Heat of boiling water.	
Bar.	rient.
30	212 ,
29	2 0·28
28	208·52
27	206·73
26	204·91
25	203·06
24	201·18
23	199·27
22	97·33
21	195·36
20	193 36
19	191 06
18	188·46
17	185 56
16	184·36
15	18 ·86
14	176·70

The accuracy of this table even in the lower part of the ſcale is ſufficiently apparent by the reſult of the experiments of Sauſſure on ebullition on Mount Blanc; for on that enormous mountain, the barometer ſtanding at 16 French inches or 17·05 Engliſh, he found water to boil at the heat of 68·993 of Reaumur, a degree which on Geneva thermometers is equal to 1 5 56 Engliſh.—Hence we ſee that diſtillation may be more advantageouſly effected on mountains than on plains, and at low barometrical heights than at the greater, yet within certain limits; for, at heights that ſurpaſs 8 or 10 thouſand feet, the fuel, by reaſon of the rarity of the air, is more ſlowly conſumed. Hence alſo, from the knowledge of the degree of the heat of ebullition to two or more decimal places, the ſtate of the barometer above or below 212° may be inferred to one or more decimal places. The reaſon of this rapid diminution of the heat of ebullition below 25 inches is evidently the diminution of reſiſtance, from the diminiſhed weight of the atmoſphere, which then is very ſenſible: but as the cold continually produced by evaporation is then ſo very conſiderable, the *time* neceſſary to procure ebullition is longer, as Sauſſure remarked on Mount Blanc. Vol. vii in 8vo, § 2011, p. 328. He found the heat of ebullition barometer 16 to be 68·993 degrees, or in Engliſh meaſures barometer 17·05. 185·5° of Fahr. (counting one of Reaumur at Geneva = 2·225 of Fahr.)

Hence ſince, according to Mr. Watt, the ſenſible heats of the vapours of boiling water at different barometrical heights are as the barometrical heights reciprocally, and the ſpecific heats

heats of the vapours of water boiling are as the ſenſible heats reciprocally, it being known, that the ſpecific heat of the vapour of water heated to 180 degrees above the freezing point is 940. The ſpecific or latent heat of the vapour of boiling water, whoſe ſenſible heat is known, (and it may be known by the barometrical height as ſhown in the above table and the notes) may alſo be diſcovered.

Thus the ſenſible heat of the vapour of boiling water barometer 30 being 180° above the freezing point (212°−32°= 180°) and the ſpecific or latent heat of vapour, whoſe ſenſible heat is 208·56° (that is 176·56 above 32°) as it is when the barometer ſtands at 28 inches, is 958 for ∴ 176·56. 180 :: 940·958 *.

As pure inviſible vapour does not in my opinion (of which I have already ſtated the grounds) exiſt in the atmoſphere when its denſity is higher than 25, as it is in moſt of the inhabited parts of the globe, but is always in this caſe united to air, an inquiry into its latent heat at different temperatures below ebullition were ſuperfluous. But as it does exiſt in air whoſe denſity is 25 or leſs, ſince it is found in air whoſe denſity is 12·5, it becomes neceſſary to examine its latent heat in ſuch caſes, in all temperatures inferior to that of ebullition. Now, by analogy, I apprehend this latent heat in all inferior temperatures may thus be determined.

As the *ſenſible* heat of ebullition, when the barometer is at 25 or below 25, is to the *latent* heat of the vapour at ebullition, ſo is the *ſenſible* heat of water heated to any inferior degree above 32° to the latent heat of its vapour, multiplied by 5·222. Thus the ſenſible heat of water in ebullition barometer 25 being 171·4° (= 203·4°−32°) its ſpecific heat is 987 $\left(=\frac{169206}{171\cdot4}\right)$ the latent heat of the vapour of water at 22° above congelation (that is 52° on Fahr. ſcale) is 657 for ∴ 171·4° 987 :: 22°. 116 × 5·22 = 657. The latent heat of vapour in ſuch caſes cannot be determined by experiment, on account of the admixture of atmoſpheric air: we muſt therefore reſort to analogy, which in this caſe is perfect.

The latent heat of pure vapour at greater heights is more conſiderable: thus at heights, at which the barometer ſtands at 20 inches, the latent heat of vapour whoſe temperature is 22° above 32°, as in the laſt caſe, is 730; for the heat of ebullition is 194·8°, per table, = 162·8°, above 32 : and the latent heat of the vapour at ebullition is 1039. Now ∴ 162·8. 1039 :: 22. 140 and 140 × 5·22 = 730.

* Hence 169206, being the product of 180° × 940, is the common dividend of all ſenſible heats *below* 180°, when the latent heat of the vapour is ſought at barometrical heights below 30 inches.

As air is cooled by the reception of moiſture diſſolved in it, we muſt infer that its capacity for containing heat is increaſed, and hence moiſt air is more difficultly heated or cooled than dry air of the ſame temperature. (or the cold proceeds from the abſorption and not from the expulſion of caloric.)

The elaſticity or expanſive force of pure vapour has been examined at every fifth degree of Reaumur above 0 to 110°, by Mr. Betancourt, and may be ſeen in an excellent work of Prony's, his *Architecture Hydraulique*: he has by a moſt ingenious calculation interpolated the expanſions anſwering to the intermediate degrees. But Mr. Schmidt ſeems to have determined this expanſive force ſtill more exactly than Betancourt. Hence I here inſert this table, adding Fahrenheit's for Reaumur's degrees, and diſtinguiſhing the expanſions interpolated by calculation from thoſe actually obſerved by *I*. The forces are meaſured by the elevation of a mercurial column in inches and hundreds of a French inch*.

Reaum.	Fahren.	Expanſive Force.	Reaum.	Fahren.	Expanſive Force.
1	34·25°	·01 *I*	21	79·25°	1·01 *I*
2	36·5	·03 *I*	22	81·5	1·01
3	38·75	·05 *I*	23	83·75	1·19 *I*
4	41·	·07 *I*	24	86·	1·29 *I*
5	43·25	·11	25	88·25	1·30
6	45·5	·15	26	90·5	1·38 *I*
7	47·75	·16 *I*	27	92·75	1·42
8	50·	·20 *I*	28	95·	1·60 *I*
9	52·25	·25 *I*	29	97·25	1·80 *I*
10	54·5	·28	30	99·5	1·93
11	56·75	·34 *I*	31	101·75	1·c2 *I*
12	59·	·38	32	104·	1·12 *I*
13	61·25	·44	33	106·25	2·23
14	63·5	·50 *I*	34	108·5	2·40 *I*
15	65·75	·55	35	110·75	2·68
16	68·	·61	36	113·	2·80 *I*
17	70·25	·69 *I*	37	115·25	3·20
18	72·5	·76	38	117·5	
19	74·75	·84 *I*	39	119·75	3·40
20	77·	·90	40	122	3·64
			80	212·	28·

* The Paris cubic inch = 1·21 Engliſh. Now the Engliſh cubic inch of mercury when its ſpecific gravity is 13·6 weighs 3443·2 Engliſh grains: therefore the Paris inch weighs 4186 Engliſh grains, and 1-10th of this inch = 418·6 grains: and 1-10th of this inch 41·86 grains.

Note.

Note.—1°. Moſt of the interpolations from the 88th degree to the 122nd I have myſelf inſerted, as thoſe calculated by Schmidt erred too widely by his own account.—Gren's Phyſ. Jour. iv. 273.

2do. Mr. Pictet has alſo made a ſet of curious experiments on the elaſticity of pure vapour in low temperatures. *Eſſais de Phyſique*, p. 157. He found that a grain of warm water in *vacuo* evaporates in forty minutes in the temperature of 38° Fahr. under a receiver containing 1452 Engliſh cubic inches*, but that it did not diffuſe itſelf equally in leſs than ſix hours, and then raiſed the hygrometer from 17° to 60°, that is 43°; and during this whole time the cold under the receiver was conſtantly decreaſing, though ſlowly; which decreaſe undoubtedly contributed to the diffuſion of the vapour.

Mr. Schmidt has alſo made a ſeries of experiments upon the dilatability of air, made as *dry* as poſſible by expoſure to hot tartarin—an object of great importance, that had never before been examined. This table I here inſert, converting Reaumur's degrees into thoſe of Fahr. and adding from his formula the degrees he omitted.

Reau.	Fahren.	Expanſion of one inch at 32°.	Reau.	Fahren.	Expanſion of one inch at 32°.
1	34·25°	·0044675		79·25°	·0938175
	36·5	·0089350		81·5	·0982850
	38·75	·0134025		83·75	·1027525
4	41·	·0178700	24	86·	·1072200
	43·25	·0223375		88·25	·1116875
	45·5	·0268050		90·5	·1116155
	47·75	·0312726		92·75	·1206225
8	50·	·035740	28	95·	·1250909
	52·25	·0402075		97·25	·1295557
	54·5	·0446750		99·5	·1340250
	56·75	·0491425		101·75	·1384925
12	59·	·0536100	32	104·	·1429600
	61·25	·0580775		106·25	·1474275
	63·5	·0625450		108·5	·1518950
	65·75	·0670125		110·75	·1563625
16	68·	·0714800	36	113·	·1608300
	70·25	·0759475		115·25	·1652975
	72·5	·0804150		117·5	·1697650
	74·75	·0848825		119·75	·1742825
20	77·	·0893500	40	122·	·1787000
				212·	·3574000

* Ibid. page 91.

Note.—1°. Hence we see that 1000 inches or measures of dry air at 32° would become 1004·4675 at 34·25 Fahr. and at 50° would become 1017·87. Hence 1000 measures of *dry* air gain 1·985555, &c. by each degree of Fahr. above 32° (or more compendiously 1·9856, which is true to two decimal places) or nearly two.

2do. We see the source of the discordant results of D'Amontons, De Luc, Lambert, Schuckburgh, Roy, Berthollet, and Monge, &c.; for they all operated upon air more impregnated with various degrees of moisture; besides taking the boiling point at different barometrical heights; in the present experiments it was taken at 29·841 English inches.

3tio. It appears that the expansions are as the differences of heat above 32°, as D'Amontons, Lambert and Schuckburgh also noticed; though their experiments, not being made on perfectly dry air, could not be very exact.

[To be continued.]

XXIV. *Some Conjectures respecting the Origin of Stones which have been observed to fall from the Clouds.* By William Beauford, *A.M.**

The falling of stones from the clouds, a natural phænomenon not generally understood, is by no means a novel circumstance in the history of nature. Several stones were observed to fall from the clouds in Yorkshire in 1360, in Bohemia and Saxony in 1480, in Bohemia about 1753, in Sienna in 1794, in Portugal in 1796, in Yorkshire in England in 1795, and near Benares in the East Indies in 1798. From an analysis made of these stones by the French academicians in 1768, and by the Royal Society of London in 1802, they are all found similar in their component parts to each other, but dissimilar to all bodies found in mines and quarries, being composed principally of four kinds of substances: the first being in the form of dark grains, composed of silex, magnesia, iron, and nickel; the second, a kind of pyrites; the third, metallic iron; and the fourth, a gray earthy substance which serves as a cement to the others, and with which they were coated. From these compositions the matter seems to be of volcanic origin; yet it is difficult to conceive how stones of any considerable magnitude could be thrown at such a distance from any volcano as those found in Bohemia, Saxony, and Britain. The nearest volcanos to Britain are those of Vesuvius, Ætna, and Hecla: a stone to be thrown into Bri-

* Communicated by the Author.

tain

tain from any of theſe, would require an impetus of between 3 and 400 miles; and, if allowance be made for the reſiſtance of the air, 1200 under the greateſt range of 2400 miles; a force not known to exiſt on the earth. It is true, volcanic aſhes, when collected in the upper regions, will be carried by the clouds to an amazing diſtance. But theſe are ſmall light aſhes, not ſtones. It is evident, therefore, if theſe ſubſtances originate from volcanic aſhes, they muſt be formed in the clouds, where thoſe aſhes, meeting with carbonic, ſulphuric, and other acids, and mixing with earthy particles drawn from terreſtrial objects, are, by the electric fluid in the lightning, precipitated from the aqueous vapours which bore them up, and, becoming united, fall to the earth in the form of ſtones; as in ſome meaſure is evinced from the flaſhes of light and detonation which accompany their fall.

Subſtances alſo of the ſame nature may be formed in the clouds without the aſſiſtance of volcanic matter; for the carbonic, ſulphuric, and aqueous vapours, which riſe from mines, furnaces, bogs, vegetables, and animals, and the ſmall particles of ſiliceous and calcareous earths which collect in the clouds, are decompoſed or made to aſſume new arrangements by the electric fire, whereby the minerals are generated and united to the earths, and conſequently fall in the form of ſtones. Thus ſtones, by means of electricity, are formed in the clouds from the ferriferous principles aſcending from volcanos, mines, and furnaces. Britain, indeed, is too far from any volcano to ſuppoſe that any quantity of volcanic matter can be waſted by the winds to this iſland; yet it contains a number of ferruginous mines and furnaces employed in the manufactory of that metal; from which proceeds an immenſe quantity of gas, containing the ferriferous matter, and ſuch matter as is generally connected with it. Beſides, there is a circumſtance not generally attended to by mineralogiſts — that all mines of whatever nature contain a mineralogical atmoſphere replete with the generic principles of the metal contained in the reſpective mines. That Nature, by her ſlow but regular operations, is daily producing metals from their elements, will hardly be denied; and whether the atmoſphere of which I ſpeak be produced by exhalations from the ingredients ſhe employs, or a part of the ingredients themſelves, the caſe will be the ſame as to the object I have in view. This atmoſphere has a ſtrong and viſible effect on the ſtones and vegetables which cover the ſoil, eſpecially that which covers mines of iron, lead, and copper. Animal and vegetable exuviæ, and other decayed mundics, ariſing from bogs, moraſſes, and dirt-hills, produce a great quantity of carbonic

and ſulphuric gaſes, containing the generic principles of iron, magneſia, and nickel, &c.: theſe, uniting with ſiliceous, argillaceous and calcareous earths, produce in great quantities that ſpecies of iron ore termed bog ore, and that in much greater quantities than is generally imagined. Theſe ores are produced in lumps from 40 to 100 lbs. and more in weight, containing from one-fourth to one-half of pure metallic iron, intermixed with pyrites and vitrified ſubſtances reſembling glaſs and petrified ſhells, the inhabitants of freſh-water lakes. Whence it is evident that a number of petrifactions and mineralizations are performed by water and air aſſiſted by the electric fluid alone; and a number of the operations of nature have been attributed by philoſophers to the effects of fire, and deemed volcanic, which are the effects of the aqueous and pneumatic elements.

In order to aſcertain in ſome reſpects the truth of this propoſition by experiment, I cauſed a quantity of gas, liberated from water by means of ſteel-filings and vitriolic acid, to be received in a glaſs veſſel, to which was added carbonic acid from the fumes of charcoal and ſulphuric gas, with the fine duſt of chalk and earth, until the whole appeared a dark thick cloud. The electric ſpark being then paſſed through it, a flaſh of light and a ſmart detonation enſued. After this operation the cloud became more tranſparent, leaving at the bottom of the veſſel a quantity of water, with a gray powder, evidently metallic, mixed with earth. If the experiment had been performed on a larger ſcale, and the ingredients varied, the reſult might have been more decided, and the phænomenon more accurately demonſtrated.

This is a ſubject that merits every philoſophic inveſtigation. The magnitude of the ſtones undoubtedly depends on the quantity of generating matter, and the height from whence it falls; yet, how ſtones of ſuch a weight as that which fell in Yorkſhire could be formed in the air, might be a ſubject of doubt, if the ſubſtance had not been found of the ſame nature as thoſe which fell in Bohemia and Sienna. But it ought to be conſidered that theſe ſubſtances are not formed inſtantaneous in the clouds: the conſtituting matter, precipitated by the electric ſhock, is thrown by the exploſion to a point, when, from the action of the air in falling, it becomes enveloped in the terra cementium with which the matter is mixed. Whence, the greater the height or range the matter has to paſs through from the time of the electric ſhock, the larger will be the ſtones. Moſt if not all the meteors formed in the air even at great heights probably originate from one cauſe: thoſe which contain the larger portion

portion of inflammable air take fire at the electric ſhock, and produce thoſe luminous and fiery meteors ſo aſtoniſhing to mankind; while thoſe which contain leſs inflammable matter, but a greater quantity of the ferriferous principles, are formed into fire-balls or ferruginous ſtones of different magnitudes, which deſcend on the earth; whilſt the more light, or thoſe which are compoſed only of inflammable gaſes, mount into the upper regions of the atmoſphere, where, taking fire, they fly off in luminous vapours. The height to which ſome of theſe vapours are carried before they are decompoſed is amazing; reaching into regions where we ſhould imagine the atmoſphere would not be of ſufficient denſity to ſuſtain them. But the natural hiſtory of the terreſtrial atmoſphere has not yet been fully inveſtigated; nor the power and effects of electricity in the formation of lithological, mineralogical, vegetable, and animal ſubſtances;—ſubjects that demand the attention of the moſt able chemiſts and ſagacious philoſophers.

Dublin,
Sept. 16, 1802.

XXV. *On the Hydrometer.* *By* WILLIAM SPEER, *Eſq.* *Surveyor and Aſſayer of Spirits in the Port of Dublin* *.

THE hydrometer, or areometer, as it is called, is an inſtrument which aſcertains the denſity of liquids, weighing unequal maſſes with the ſame weight.

This inſtrument is of great antiquity, and until lately it was ſuppoſed to have been invented at the end of the fourth century, by Hypatia, the daughter of Theon, the celebrated mathematician of Alexandria: but M. Uſebe Salverte, in a memoir on this ſubject, in the *Annales de Chimie*, vol. xxii. has demonſtrated its having been invented by Archimedes three hundred years before the period in which Hypatia was born; and the very elegant Latin deſcription he gives of this inſtrument, from an author of great antiquity, ſhows that, in the form, ſeveral of thoſe now in uſe differ but little from that of the original invention.

This inſtrument, from the facility and expedition with which it may be applied, has long been in uſe for aſcertaining the ſpecific gravity of various kinds of liquids; but its application to the particular purpoſe to which it is now uſed is comparatively of modern date.

* Extracted from his "Enquiry into the Cauſes of the Errors and Irregularities which take place in aſcertaining the Strengths of Spirituous Liquors, &c. London 1802."

Until within a period of about forty years, the ſtrengths of ſpirituous liquors were moſtly aſcertained by other modes, both in Great Britain, Ireland, and on the Continent.

Proof by oil, by agitation, by firing gunpowder, by alkaline ſalts, and by glaſs bubbles, has been uſed, but in every caſe found defective; and the hydrometer was at length reſorted to, as an inſtrument calculated to aſcertain theſe ſtrengths with leſs trouble and greater accuracy.

To obtain indications of ſtrengths by it correctly, however, depends on circumſtances that have not, until lately, been ſufficiently underſtood or aſcertained; on which account the inſtrument has been complicated in various ways, by weights and ſliding rules: theſe, in ſome caſes, have rather increaſed than diminiſhed its irregularity.

The object of the following inquiry is therefore to bring into one view all the cauſes of thoſe imperfections and irregularities, and, by ſo doing, to prepare the way for their removal.

Thoſe irregularities have ariſen from ſeveral cauſes. In the firſt place, when Clarke's hydrometer was conſtructed (forty years ago), the effects of expanſion by heat, and contraction by cold, on the ſpecific gravity of ſpirituous liquors, had not been accurately aſcertained; nor was the diminution of bulk by penetration (or concentration, as it is improperly called,) well underſtood.

In this ſtate of ignorance of theſe effects, Clarke's hydrometer was conceived to be a great improvement on that which had been in uſe before it. Preciſely the ſame kind of advance in improvement had been made in the Iriſh hydrometer, ſomewhat nearly about the ſame period. The duty on ſpirits in both kingdoms previous to this time was paid only on two denominations, viz. ſingle and double ſpirits: the former was proof, or under it, and the latter all ſuch as were over proof; and this diſcrimination of ſtrength was made either by a rude ſort of inſtrument which hardly deſerved the name of hydrometer, or by dropping oil into the ſpirit: if the oil floated, it was called ſingle; if it ſunk, it was double.

The preſent Iriſh hydrometer was adopted about two or three years after Clarke's hydrometer in England; both of which purporting to diſcriminate the increaſe of ſtrength by *per centages* *, ſo as to proportion the additional rate of duty to

* As this term occurs frequently in the following eſſays, and may not, perhaps, be clearly underſtood by all my readers, it may not be amiſs to explain it here:—A ſpirituous liquor is ſaid to be ten per cent. over hydrometer proof when it is ſo ſtrong that one hundred gallons of it will admit

to the relative increaſe of overproof, were conſidered great improvements; and though, from the conſtruction of Clarke's hydrometer, it was evident that the variations occaſioned by change of temperature were then *ſomewhat* known; yet in Ireland the effects of theſe variations were conceived ſo immaterial, and the numerous weights attached to this inſtrument, the difficulty of underſtanding it, the certain delay and probability of miſtake, were conſidered to be ſo objectionable, that it was deemed better to uſe an hydrometer which paid no regard to temperature, than to uſe one liable to ſo many other objections. The variations by the ordinary change of temperature being, however, from one to fifteen *per cent.*, this defect in the conſtruction of the Iriſh hydrometer is ſo manifeſt, that it is preſumed it would be a waſte of time to attempt any demonſtration of its incompetency.

Although Clarke's hydrometer has not been conſtructed without a reference to temperature, yet this has been attended to only in part; and the inſtrument being otherwiſe very defective, it will be neceſſary to exhibit theſe defects, in order that they may be guarded againſt in ſuch hydrometer as ſhall be adopted inſtead of it.

Till Clarke's hydrometer was adopted, which, from the beſt information I can obtain, took place about the year 1762, proof ſpirit was made by mixing equal portions of water and the ſtrongeſt ſpirit which could be procured: but it being ſometimes difficult to obtain this proof ſpirit for compariſon, ſuch a mixture was made by order of the honourable board of exciſe; and it was found, that when ſix gallons of it were mixed with one gallon of water, a wine gallon of the mixture weighed ſeven pounds thirteen ounces avoirdupoiſe: the board therefore declared, that the ſpirituous liquor, of which the gallon weighed ſeven pounds thirteen ounces, ſhould be reckoned one *to* ſix, or one *in* ſeven *under* proof.

This definition of proof was adopted in order to accord with a mode of examination which had been long in uſe, and ſanctioned by the board.

The hydrometer ſaid to be invented by Mr. Clarke * was at

admit an addition of ten gallons of water to reduce it to the ſtrength of proof; and it is ſaid to be ten per cent. under proof when one hundred gallons contain ten gallons of water more than proof contains.

* In 1772 the States of Languedoc offered a premium for the beſt memoir on the ſubject of aſcertaining the ſtrength of brandies. This premium was adjudged, by the Royal Society of France, to M. Bories, M. D. whoſe inveſtigation and experiments on this difficult ſubject have, I humbly conceive, been ſurpaſſed only by thoſe of the Royal Society in this country. Speaking of the various methods he had tried, he ſays: "J'eus recours

at this period brought forward, which having a ſet of weights correſponding to the above-mentioned mixture of water and proof ſpirit, and the mixture of one *to* ſix, or one *in* ſeven, being that only which weighed an exact number of pounds and ounces, without a fractional part, per gallon, by the ſtatute of the 2d of George III. this obſcure mode of aſcertaining proof was adopted. At this time, the effects of heat and cold, on the trial of the ſtrength of ſpirits by the hydrometer, had not been clearly underſtood; and though Clarke's hydrometer, which was then adopted, by having, in addition to the weights uſed for aſcertaining the ſtrengths of ſpirits, another ſet of weights called weather weights, adapted to ſeveral temperatures, is a demonſtration that theſe effects were not altogether unknown; yet they were conſidered ſo immaterial as not to require the mention of temperature in the act of parliament. This omiſſion has added conſiderably to the irregularities of the various hydrometers ſince in uſe, as by it the legal ſtandard for proof is rendered very uncertain, and will, by the ordinary change of temperature, vary from five to ſix per cent.

I here beg leave to quote an obſervation of ſir Charles Blagden, from the Proceedings of the Royal Society in 1790, in his Report on the beſt Method of proportionating the Exciſe upon Spirituous Liquors made by Deſire of Government:

"By the act of 2d George III. it is ordered, that the gallon of brandy or ſpirits, of the ſtrength of one to ſix under proof, ſhall be taken and reckoned at ſeven pounds thirteen ounces (which is underſtood by the trade to mean 55 of heat). Hence taking the weight of a gallon of water at the ſame heat to be 8 lb. 5 oz. and 66 parts, the ſpecific gravity of this diluted ſpirit will be found 9335 at 60: this ſpecific gravity indicates a mixture of 107 grains of water with 100 grains of pure ſpirit; whence, by a computation founded on the tables in this report, the ſpecific gravity of proof ſpirit will come out 916: but the rules of correction belonging to Dicas and Quin's hydrometer give the ſpecific gravity of proof ſpirits about 922, at 55, equivalent to 920, at 60. The former, 916, correſponds to a mixture of 100 parts of ſpirit with 62 by meaſure, or 75 by weight of water; and the latter, 920, to a mixture of 100 parts of ſpirit, and 66 by mea-

recours à la méthode de Fahrenheit: j'ai vu depuis, qu'elle avoit été miſe en uſage par M. Briſſon. J'entends par cette méthode celle de l'aréométre gradué par Fahrenheit, et ſuivi par Clarke et Defaguliers." He afterwards deſcribes the inſtrument, and condemns it for its complications, and being improperly graduated: from this it would appear that this inſtrument was invented by Fahrenheit, and not by Clarke.

ſure, or 80 by weight of water. The difference is conſiderable, but the firſt is undoubtedly moſt conformable to the exiſting acts of parliament: if, therefore, it be thought right to preſerve the term *proof ſpirit* in our exciſe laws, it may be underſtood to mean ſpirit whoſe ſpecific gravity is 916, and which is compoſed of 100 parts of rectified ſpirit at 825, and 62 parts of water, by meaſure, or 75 by weight; the whole at 60 degrees of heat."

From this extract it appears there are no leſs than three imperfections in this manner of defining proof ſpirits. Firſt, the ſpirit defined is not proof, but another ſpirit, one *to* fix, or one *in* ſeven, under proof, requiring a ſubſequent proceſs to make proof: ſecondly, the difficulty of procuring an exact gallon meaſure.

The late ingenious Mr. Ramſden, in a publication on this ſubject, printed in 1792, ſpeaking of the ſtandard of proof, ſays: "Hydrometer-makers differ on this point $7\frac{1}{2}$ per cent.; and government, to avoid diſputes, have been under the neceſſity of paſſing an act to conſtitute Clarke's hydrometer (for a ſhort time) the only legal one, though it is, in all probability, as vague as any of the others, particularly in ſpirits conſiderably higher than proof. An obſtacle to aſcertaining this term (ſays he) ariſes from the difficulty of obtaining *practically* the exact capacity of our gallon meaſure: it is, indeed, ſtated to contain 231 cubic inches; yet, notwithſtanding the great pains taken by a committee of the houſe of commons, about the year 1758, for that purpoſe, aſſiſted by ſeveral ingenious mechanics, this point was left undetermined. The method they uſed was making *hollow cubes* of different dimenſions, from one inch upwards, which were executed with great care by the late Mr. J. Bird, and are now in the repoſitory of the houſe of commons: but whoever conſiders the difficulty of making an exact cube, and that of aſcertaining the inſide calibre with preciſion, muſt be ſenſible that no great reliance can be had on the exactneſs of a gallon meaſure obtained by this method."

Thirdly, that no temperature being mentioned, the ſtrength is doubtful; and though ſir Charles, in this part of his Report (which has not, I believe, been contradicted), ſays the trade conſiders the temperature to be 55, and that proof ſpirit ſhould be as he ſtates, by the unerring teſt of the ſpecific gravity 916, at 60, (and which would be 918, at 55;) yet the ſpecific gravity of proof ſpirit, by Clarke's hydrometer, is 924, at 55 of temperature.

From this it appears, that even Quin's and Dicas's ſtandards of proof are erroneous to an extent of three per cent.; and

and that Clarke's is nearly four and a half different from the ſtrength preſcribed by the ſtatute: this is ſuppoſing the temperature to be what ſir Charles ſays it is conſidered by the trade.

In Ireland the ſtandard of proof is ſtill more uncertain, no definition of it whatever appearing on the ſtatute, but reſting ſolely on the practice which prevailed in England prior to the 2d of his preſent majeſty, viz. mixing water with an equal portion of rectified ſpirits of wine, as it is called, no ſpecific gravity of the ſpirit mentioned, and the ſpirit, called rectified ſpirit of wine, differing materially in point of ſtrength: neither has the temperature been attended to, the hydrometer there having no thermometer attached to it: the ſtandard of proof has conſequently become juſt what the maker of the Iriſh hydrometer pleaſed: the generally received opinion, however, ſuppoſes it to be nine per cent. over Engliſh hydrometer proof.

Two material imperfections appear in Clarke's hydrometer, excluſive of its complexity; namely, that neither variations of temperature, nor the gradations of ſtrengths, have been ſufficiently attended to: with reſpect to the former of theſe, the ſame weather-weight (as it is called by the trade) is uſed, though the temperature ſhould vary four or five degrees.

The inventor, foreſeeing that this was liable to weighty objections, conceives he has guarded againſt it by the direction he gives in a N. B.: but this N. B., ſo far from removing doubts, only ſerves to increaſe them: the words *about* and *near* leaving room for much to be gueſſed at, and much more to be apprehended, where the important points it alludes to are ſo looſely and indiſtinctly defined.

May I be permitted in this place to explain the conſequences of this mode of including four or five degrees of temperature to be indicated by the ſame weight, by ſtating a caſe that has frequently occurred?—A merchant in Ireland ſhips for London a quantity of ſpirit, and previous to its ſhipment examines the ſtrength by Clarke's hydrometer: he adjuſts the ſtrength to be ſomewhat leſs than 10 per cent. (ſuppoſe 9½) over hydrometer proof, the ſtrength allowed to be importable without an augmentation duty: this ſpirit is per ſpecific gravity 910, temperature 55. Suppoſe it to be arrived in London, but the temperature is then 60; notwithſtanding this increaſe of temperature (of 5 degrees) the ſame weather-weight continues to be uſed in trying the ſtrength in England which was applied in Ireland: by this increaſe of temperature, the ſpecific gravity being diminiſhed to 907, ths, when it comes to be proved in London, by the ſame hydrometer,

meter, it then appears to be full one and a half per cent. ſtronger than when it was ſhipped, and will now be found to be 11 per cent. over proof. Should this ſpirit be a foreign one, viz. brandy or geneva, it muſt pay the entire augmentation duty of 11 per cent.; whereas, if the temperature was ſufficiently diſcriminated, it ſhould have paid no augmentation duty whatever.

That this caſe is not merely a ſuppoſition, is, I believe, well known to ſeveral reſpectable merchants in London, to whom conſignments of foreign ſpirits have been made from Ireland, and who, in ſeveral inſtances, have been obliged to pay this augmentation duty of 11 per cent. Here, therefore, the inſtrument proves its own errors; nor can additional weights remedy it.

The principle on which it is conſtructed ſuppoſes that the ratio of expanſion by heat is the ſame in ſtrong as in weak ſpirits; the ſame weight for temperature is therefore applied to both: this is totally erroneous, and is demonſtrable thus:

Suppoſe a weak ſpirit to be tried, the ſpecific gravity of which, at the temperature of 35, is 960·48, let the temperature be increaſed to 70, the ſpecific gravity will be 948·13; the diminution, conſequently, is 12·35.

Suppoſe next, the ſpirit under trial to be a ſtrong one, and is per ſpecific gravity at 35, 843·49; increaſe the temperature, as in the firſt, to 70, the ſpecific gravity will be only 827·01: diminution in this ſpirit 16·48; *difference* in the ratio of expanſion 4·13; this difference making full three per cent. by the hydrometer, and thus demonſtrating a radical defect in the inſtrument which *cannot be cured by additional weights.*

The ſpirituous liquors of commerce being mixtures of pure ſpirit and water, and the value of this, and the duty to be paid on it, depending on the quantities of the former which are contained in the mixture, it becomes neceſſary to aſcertain the proportion in which it enters into every ſuch mixture.

The eaſieſt and moſt expeditious mode of aſcertaining this is by an hydrometer, which acts on the following well-known principles of hydroſtatics.

A ſolid body deſcends in a liquid, becauſe it is heavier than an equal bulk of the liquid: and it deſcends with a force or weight equal to the exceſs of its own weight, over the weight of an equal bulk of the liquid; or, if it be lighter than an equal bulk of the liquid, it aſcends with a force proportioned to the difference of weights; but if it be of the ſame weight as an equal bulk of the liquid, it will remain where it is placed.

Hence

Hence it is evident that every variation of gravity in the liquid will affect the indication on the hydrometer.

This gravity is known by the term *ſpecific gravity*; and as the ſpecific gravity of liquids is not abſolute, but relative, this can only be determined by compariſon: the firſt operation, therefore, conſiſts in getting one whoſe abſolute weight is known, in order to ſerve as a fixed point, and to determine, in its turn, a compariſon of the denſity of the liquid. Pure water having always been conſidered the beſt ſtandard for this purpoſe, the term ſpecific gravity is moſt readily defined, by ſaying, that it is as the weight of the liquid is comparatively with pure water: for inſtance, if a phial, which holds preciſely 1000 grains of water, holds only 922 grains of a ſpirituous liquor, the ſpecific gravity of this ſpirit is ſaid to be 922.

But as ſpirits expand by heat, and contract by cold, this ſpecific gravity varies according to the degree of the heat of the liquor, which is called its temperature: therefore it is neceſſary firſt to aſcertain what that may be, and it is done very accurately by the thermometer. And in the experiment mentioned, ſuppoſing the temperature to have been 55, if the ſpirit be heated to 70, the ſpecific gravity will be diminiſhed to 915½; and, if afterwards it be cooled down to 35 degrees of temperature, it will be found to have increaſed to 930½.

This is a very convenient manner of trying and expreſſing what the ſpecific gravity of the liquor may be; and as I ſhall hereafter have occaſion to uſe the term frequently, I hope I ſhall be excuſed for explaining it in this place.

All the variations of the ſpecific gravity of ſpirituous liquors, and the cauſes of them, may be compriſed under the following heads, viz.

1ſt, Thoſe ariſing from heat and cold: 2dly, A difference in the proportions of the ſpirit and water: and, 3dly, The effects of penetration (or, as it is called, concentration), which takes place on the mixture; all of which, being ſo clearly defined by ſir Charles Blagden, in his Report on this ſubject, in the ſecond part of the 80th volume of the Tranſactions of the Royal Society, I ſhall beg leave to give it in his words, and lament that the propoſed limits of this work will not permit me to give the entire Report, every paragraph of which I conceive to be important, and demonſtrates the difficulties with which this ſubject is enveloped, and very clearly points out the way to remove them.

"Though (ſays ſir Charles) various indications of the ſtrength's

ſtrengths of ſpirituous liquors have been deviſed, applicable in a groſs manner to a general uſe, it is well known that no method admits of real accuracy but that of the ſpecific gravity. The weights of an equal bulk of water and pure ſpirit differ from one another by at leaſt a ſixth part of the weight of the former; whence it is obvious, that when thoſe two fluids are mixed together, the compound muſt have ſome intermediate ſpecific gravity, approaching nearer to that of water or pure ſpirit, as the former or the latter is the more predominant ingredient.

" Were it not for a certain effect attending the mixture of water and ſpirit, which has been called their mutual penetration, the ſpecific gravity of theſe compoſitions, in a given degree of heat, would be ſimply in the arithmetical proportions of the quantity of each of the fluids entering into them.

" But whenever different ſubſtances, which have a ſtrong tendency to unite together, are mixed, the reſulting compound is found to occupy leſs ſpace than the ſubſtances forming it held in their ſeparate ſtate; wherefore the ſpecific gravity of ſuch compounds is always greater than would be given by a ſimple calculation from the volume of their ingredients. Though it be a general fact, that ſuch a decreaſe of bulk takes places on the mixture of ſubſtances which have a chemical attraction for each other; yet the quantity of this diminution is different in them all, and, under our preſent ignorance of the intimate compoſition of bodies, can be determined by experiment only. To aſcertain, therefore, the quantity and law of the condenſation reſulting from this mutual penetration of water and ſpirit, was the firſt object to which the following experiments were directed.

" All bodies, in general, expand by heat: but the quantity of this expanſion, as well as the law of its progreſſion, are probably not the ſame in any two ſubſtances. In water and ſpirit they are remarkably different. The whole expanſion of pure ſpirit, from 30° to 100° of Fahrenheit's thermometer, is not leſs than 1-25th of its whole bulk at 30°; whereas that of water, in the ſame interval, is only 1-145th of its bulk. The laws of their expanſion are ſtill more different than the quantities. If the expanſion of quickſilver be, as uſual, taken from the ſtandard (our thermometers being conſtructed with that fluid), the expanſion of ſpirit is, indeed, progreſſively increaſing with reſpect to that ſtandard, but not much ſo within the above-mentioned interval; whilſt water kept from freezing to 30°, which may eaſily be done, will abſolutely contract as it is heated, for ten or more degrees,

degrees, that is, to 40° or 42° of the thermometer, and will then begin to expand as its heat is augmented, at firſt ſlowly, and afterwards gradually more rapidly, ſo as to obſerve upon the whole a very increaſing progreſſion.

"Now mixtures of theſe two ſubſtances will, as may be ſuppoſed, approach to the leſs or the greater of thoſe progreſſions, according as they are compounded of more ſpirit or more water; whilſt their total expanſion will be greater according as more ſpirit enters into their compoſition: but the exact quantity of the expanſion, as well as the law of the progreſſion, in all of them, can be determined only by trials. Theſe were therefore the two other principal objects to be aſcertained by experiment." Sir Charles then proceeds to deſcribe thoſe various experiments, and which are too long to admit an inſertion of them here; but from a peruſal it will be perceived they were conducted with a degree of patient inquiry, minuteneſs of attention, and accuracy of inveſtigation, ſeldom to be met with, and which, with the calculations grounded on them by Mr. Gilpin, clerk of the ſociety, and publiſhed in the Tranſactions for 1794, have removed thoſe obſcurities with which the ſubject had heretofore been enveloped.

Theſe celebrated experiments, and the table deduced from them, have been minutely examined by ſeveral of the ableſt philoſophers in France and various other parts of the continent, and they are allowed to be what Mr. Nicholſon (who has alſo minutely examined them), in his Chemical Dictionary, ſays, may be conſidered as fundamental reſults; and it is ſomewhat remarkable that, ſince their publication in 1794, no perſon has hitherto availed himſelf of the important information they contain, as a foundation for putting a period to thoſe irregularities and uncertainties which have been ſo long and ſo univerſally complained of.

That hydrometers ſhould be complicated in their ſtructures, and erroneous in their indications, previous to this period, is not to be wondered at.

The ſpecific gravity of the ſpirit, which is the foundation of the hydrometer indication, was but little attended to; and thoſe variations which take place in the ſpecific gravity, through the ſeveral cauſes above mentioned, having never before that period been preciſely aſcertained, hydrometers, inſtead of being graduated by this unerring teſt, have been graduated by compariſon with another inſtrument, called a ſtandard, but no means have been pointed out to prove that this ſtandard was correct.

Theſe tables of Mr. Gilpin, however, furniſh ſuch elemen-

tary information as has enabled me, by the addition of four columns, to remove all doubts and uncertainties on the ſubject, by demonſtrating, from the ſpecific gravity of the ſpirituous liquor, what the hydrometer indications ſhould be of every gradation of ſtrength.

In the Report, which accompanies theſe tables, ſir Charles Blagden makes an obſervation which firſt ſuggeſted to me the utility of theſe additional columns.

"It may very probably be thought right (ſays he), for the future uſe of the revenue, to compute another ſet of tables, in which the degrees of heat ſtanding at the head of each table, the firſt column of it ſhall be even numbers of ſpecific gravity. This would be proper for looking out at once the quantities of ſpirit and water in a mixture from its heat and ſpecific gravity."

Sir Charles, by this obſervation, alludes not to the means of obtaining the hydrometer indication, but to an opinion he had given in his firſt Report, in 1790, that the ſimpleſt and the moſt equitable way of levying the duty on ſpirituous liquors would be to conſider pure ſpirit as the true and only exciſeable matter, inſtead of the relation to the ſtandard of proof, and for calculating which one column of the table is a decimal multiplier, to aſcertain the proportion of this in any given quantity of a ſpirituous liquor; an idea which certainly is ingenious, and, at firſt view, appears to have the recommendation of ſimplicity: but as every diſcrimination of ſtrength would require an operation of figures, fractions would unavoidably occur, from which, and the delay and danger of errors in theſe operations, this mode, I conceived, had been conſidered practically inconvenient, and therefore was not adopted.

The relation to the ſtandard of proof having been long recognized by the different ſtatutes, and in commerce, I thought it probable it would not be laid aſide; nor was it, as I conceived, neceſſary to do ſo when a means preſented itſelf of rendering this relation to proof equally correct as that which he pointed out: and the new ſet of tables, which at firſt I apprehended he was about to deſcribe as uſeful for the revenue, were thoſe which would deduce the hydrometer indication of ſtrength from the ſpecific gravity of the ſpirit at a given temperature. A table for this purpoſe would, I conceived, be importantly uſeful on ſeveral accounts: 1ſt, it would afford a mode of graduating an hydrometer on a certain principle; and, 2dly, that as it furniſhed a ſtandard for every gradation of ſtrength, errors could be diſcovered in thoſe inſtruments that have been graduated by the deluſive mode of

 compariſon,

compariſon, many of whoſe diſcriminations of ſtrength being, as I had reaſon to believe, merely conjectural.

Before I proceed to explain Mr. Gilpin's tables, and the columns added to them, it becomes neceſſary to define what is meant by the term *pure ſpirit*, and to inquire whether the ſpirit which ſir Charles deſcribes can with propriety be called ſuch.

"The firſt ſtep (ſays he, in the Report made on this ſubject in 1790) towards a right performance of the experiments, was to procure the two ſubſtances with which they were to be made, as pure as poſſible. Diſtilled water is in all caſes ſo nearly alike, that no difficulty occurred with regard to it; but the ſpecific gravity of pure ſpirit, or alcohol, has been given ſo very differently by the authors who have treated of it, that a particular ſet of experiments appeared neceſſary for determining to what degree of ſtrength rectified ſpirit could conveniently be brought. The perſon engaged to make theſe experiments was Dr. Dollfuſs, an ingenious Swiſs gentleman, then in London, who had diſtinguiſhed himſelf by ſeveral publications on chemical ſubjects. Dr. Dollfuſs, having been furniſhed by government with ſpirit for the purpoſe, rectified it, by repeated and ſlow diſtillations, till its ſpecific gravity became ſtationary in this manner of operating: he then added dry cauſtic alkali to it, let it ſtand for a few days, poured off the liquor, and diſtilled it with a ſmall addition of burnt alum, placing the receiver in ice. By this method he obtained a ſpirit whoſe ſpecific gravity was 8188, at 60 of heat. Perceiving, however, that he could not conveniently get the quantity of ſpirit he wanted lighter than 82527, at 60, he fixed upon that ſtrength as a ſtandard.

Several highly reſpectable authorities might be produced to prove this ſpecific gravity to be a proper ſtandard for *pure ſpirit*.

[To be continued.]

XXVI. *A ſhort Account of the Mammoth.* By Mr. Rembrandt Peale *.

THE mammoth is ſo called from the Ruſſian name, ſuppoſed to have been derived from the Hebrew *Behemoth*, Job, chap. xl. It is properly continued, both words being expreſſive of a large and extraordinary animal.

For a number of years paſt many large and extraordinary

* Communicated by the Author.

bones

bones and teeth have been diſcovered both in Siberia and America, which at firſt were generally attributed to the elephant *, except ſome very large teeth of the carnivorous kind totally different from thoſe of any animal known.

In Siberia they were attributed to the mammoth, whoſe fabulous exiſtence they ſuppoſed to be under ground, and of which Iſbrand Ides pretends to give a deſcription. In North America theſe large bones and carnivorous grinders have been found in great abundance on the Ohio and its tributary ſtreams, waſhed from their banks, or diſcovered by digging in ſalt moraſſes in the neighbourhood of Cincinatti; where they are found intermixed with the bones of buffaloes and deer, which a tradition of the Indians ſtates to have been deſtroyed by a herd of theſe animals which came upon them from the north. This event happened, the Indians believe, as a puniſhment for their ſins; but they ſay the good ſpirit at length interpoſed to ſave them, and, ſeating himſelf on a neighbouring rock, where they ſhow you the print of his ſeat and of one foot, hurled his thunderbolts among them. All were killed except one male, who, preſenting his forehead to the ſhafts, ſhook them off, until, at length wounded, he ſprung over the Wabaſh, the Illenois, and the Great Lake, where he ſtill lives.

Theſe bones were forwarded with great eagerneſs to all parts of Europe, and depoſited in muſeums, where they attracted the curioſity of all naturaliſts, whoſe conjectures and theories on them were very various, until Dr. Hunter, by a more accurate compariſon between them and the bones of other animals, determined that they muſt have belonged to a large non-deſcript animal of the carnivorous kind, ſomewhat reſembling the hippopotamus and the elephant, yet eſſentially different from both.

The ſubject is now completely elucidated. Not long ſince ſome farmers in the State of New York, in America, digging marle from their moraſſes in the neighbourhod of New-Windſor, accidentally diſcovered ſeveral of theſe bones, which were preſerved by phyſicians in the neighbourhood. In the autumn of 1801, my father Charles W. Peale and myſelf, having obtained poſſeſſion of theſe bones, perſevered for nearly three months, at the expenſe of much time, labour, and money, in a ſearch for the remainder of the animal; and were fortu-

* Naturaliſts were led to this idea in conſequence of finding, in a few inſtances in America, but frequently in Siberia, ſome large graminivorous teeth, which probably belonged to an animal of the elephant kind, though certainly of different ſpecies from any known: theſe teeth are remarkable for ſize, and in the number of lamellated veins of enamel which pervade them.

nate enough to obtain two ſkeletons, found in two diſtinct ſituations, and unmixed with bones of any other individual whatever: one of theſe is preſerved in the Muſeum at Philadelphia, and the other is now exhibiting in the Old Academy-room, Pall-Mall, previouſly to its being taken to Paris.

The ſkeleton of the mammoth bears ſome general reſemblance to that of the elephant, yet on examination even the general figure is found to be conſiderably different; principally in the effect of the tuſks, ſtructure of the head, prominence and pointedneſs of the back over the ſhoulders, its great deſcent thence to the hips, together with the comparative ſmallneſs of the body and the neceſſarily detached effect of the hind-legs—proofs of greater activity than in the elephant. On a cloſer examination, the characteriſtic features are greatly multiplied; and with reſpect to the hind-legs, the idea of activity is confirmed from the ſtructure of the thigh-bones, which are extremely broad and flat, and well adapted for great exertions of ſtrength, beyond that of the elephant, whoſe thigh-bones are not flat, but round. This effect of ſtrength likewiſe prevails in the ribs, which are of a very unuſual ſtructure, being bent edgewiſe and having their greateſt thickneſs at top, gradually becoming ſmaller towards their junction with the cartilage; whereas in the elephant they are bent flatwiſe, like thoſe of the ox, and are narrow at top and broad at the lower ends. This peculiarity in the ribs of the mammoth is worthy of particular notice, not only on account of the unuſual poſition of ſtrength, but becauſe, from their diſtance between each other, they ſhow the animal to have had conſiderable flexibility in its body; to which the breadth and proximity in the ribs of the elephant, as well as the ox, are a certain impediment. Beſides, as I obſerved before, the body is comparatively ſmaller, in conſequence of the ſmall length of the ribs.

The ſpines of the back over the ſhoulders are of an unuſual magnitude, which gives the appearance of a hump, like the biſon, and are calculated to give power and motion to the head. Thoſe in the elephant are not ſo large over the ſhoulders, but much more ſo all the way to the ſacrum: conſequently his back is more arched. The proportionate length of the proceſſes from the ſpine of the ſcapula differs eſſentially from all other animals. And, independently of any other variation in form, all the bones, of the limbs in particular, are aſtoniſhingly thick and ſtrong.

We now come to the head, where the moſt ſtriking features of this animal are to be found; and ſince between the correſponding parts of all animals there is a general analogy, it is the

the province of comparative anatomy not only to trace out the points of diſtinction, but, ſince they originate from certain fixed principles, in the diſcrimination of variations, to confirm their propriety by an examination of the principles on which they are founded.

Although it is ſufficiently evident to thoſe who are accuſtomed to this kind of inveſtigation, from the obſervation of a few facts, that this animal muſt have been carnivorous; yet to others it is neceſſary to introduce every proof and concluſive evidence. Many perſons, from a falſe impreſſion, believe that teeth are determined to be carnivorous merely from their having a rugged ſurface: with this opinion they very properly aſk, "May not the vegetable food be of a coarſer quality?" It is true that the ſurface is roughest on thoſe graminivorous teeth which are employed in the maſtication of the coarſeſt vegetable ſubſtances, not only becauſe ſuch roughneſs is requiſite, but becauſe the teeth are rendered ſo from the quality of the food, the bony interſtices wearing down more eaſily than the ridges of enamel, which operate as the roughneſs in a mill-ſtone. It is not therefore from this ſpecies of roughneſs that we preſume on ſo important a determination: the roughneſs exiſting on the ſurface of carnivorous teeth is of another nature, much more ſtrongly marked, and far from being rendered ſo by uſage: the more they are uſed, the more even do they become. The tooth of a graminivorous animal is compoſed of *alternate veins* of enamel and bone, which thus pervade the whole mass: thoſe of carnivorous animals are covered with a ſhell or cruſt of enamel, which is merely external, and exiſts as well in the cavities as on the ridges; which is not the caſe with other teeth. This enamel is required in the cavities, becauſe the teeth interlock with each other, the prominences ſtriking into the cavities.

An uniform compoſition of tooth, as it reſpects the intermixture of enamel and bone, is obſerved to prevail in thoſe of the elephant, horſe, ox, &c. principally differing from each other in the *figure* which thoſe veins of enamel aſſume, and by which alone they may be diſcriminated among themſelves. On the other hand, carnivorous teeth, incruſted with enamel as far as the gums, yet vary in the form and number of their protuberances, ſo as generally to deſignate their ſpecies: yet among them there is a very proper diſtinction to be obſerved, which is, that thoſe carnivorous animals, the form of whoſe teeth and the attachment of whoſe jaws allow them the ſide or grinding motion, are always of the mixt kind. Man, the monkey, hog, &c. are carnivorous ani-

mals, becauſe their teeth are incruſted with enamel, and becauſe they do eat fleſh; yet they are adapted for other food, by the rotatory motion of their jaws and the form of their teeth: this rotatory motion does not exiſt in the jaws of thoſe animals which live entirely upon fleſh; for they are attached by an oblong head or proceſs inſerted into a tranſverſe groove, and conſequently have no other motion than up and down. In graminivorous animals the under jaw is attached by means of a conſiderably round head (condyloid proceſs) to a prominence or flat ſurface, ſo that they *rotate*; and, to favour this motion, the coronoid proceſs is generally thicker and not ſo long as the condyloid; whereas in carnivorous animals the coronoid proceſs is extremely flat and long, being never acted on except lengthwiſe.

But it muſt not even be ſuppoſed that an animal may be of the mixt kind, unleſs we obſerve a capacity for maſtication; without which we muſt declare it excluſively carnivorous.

Some object to the carnivorous nature of the mammoth from its not having cutting or canine teeth. To this it may be replied, that if we form our rule of judgment, as to what conſtitutes a graminivorous animal, from the conſtruction of an ox's jaw, the elephant would certainly be excluded, becauſe it has not *inciſores* at leaſt in the lower jaw: the fact is, that all carnivorous as well as graminivorous animals differ among themſelves with reſpect to the number and ſituation of their teeth; and hence they afforded to the ſagacious and celebrated Linnæus the moſt infallible method of claſſification, which has ſince been adopted, either wholly or partially, by all naturaliſts. The proboſcis of the elephant anſwers the purpoſe of *inciſores*: he therefore requires no others than grinders, which entirely fill his jaws: hence he is completely graminivorous. And although the mammoth is deficient in cutting teeth, and has no other canine teeth than his enormous tuſks, the deficiencies of which may have been ſupplied by a pair of large and powerful lips, indicated by the uncommon ſinuoſity on the front of the lower jaw; yet I am decidedly of opinion, ſince it cannot be contradicted by a ſingle proof or fact, that the mammoth was excluſively carnivorous; by which I mean, that he made no uſe of vegetable food, but either lived entirely on fleſh or fiſh; and not improbably upon ſhell-fiſh, if, as there are many reaſons to ſuppoſe, he was of an amphibious nature. I therefore only require aſſent to theſe facts: 1ſt, The teeth are certainly of the carnivorous kind: 2dly, They are not of the mixt kind, becauſe they have not the leaſt rotatory motion, and

and ſo completely lock together: 3dly, Since, therefore, they are not graminivorous, ſince they cannot be of the mixt kind, from a defect in motion, they muſt be excluſively and poſitively carnivorous.

Independently of the teeth, the under jaw of the mammoth differs moſt eſſentially from that of the elephant, which in its outline is ſemi-circular, from the condyle to the chin; whereas in the mammoth the outline is diſtinctly angular, and is much greater in the length than it is in the height, which is the reverſe in the elephant: beſides ſeveral other ſtriking diſtinctions in both jaws.

When the ſkeleton was firſt erected, I was much at a loſs how to diſpoſe of the tuſks; their ſockets ſhowed that they grew out forwards, but did not indicate whether they were curved up or down. I choſe, therefore, firſt to turn them upwards, not becauſe they produced the ſame effect as in the elephant, for it is evident they could not in any poſition, owing to two circumſtances. In the elephant, taking the level of the teeth for a horizontal baſe line, the condyle of the neck is at right angles with it; and the perpendicular, one third longer than the baſe line: hence they are uſeful on every occaſion, the tuſks themſelves being nearly ſtraight, and pointing downwards; whereas in the mammoth, taking the level of the teeth for a baſe line, the condyle of the neck is ſituated but a few inches above it: conſequently the ſockets for the tuſks and the condyle of the neck are in a horizontal direction: this circumſtance, together with the extraordinary curve of the tuſks, would raiſe the points in the air, directed in ſome degree backward over the head, twelve feet from the ground, and never could have been brought lower than ſix or ſeven feet from it. This poſition was evidently abſurd: I therefore reſolved on reverſing them; in which poſition, in conſequence of their twiſt or double curve, they appear infinitely more ſerviceable.

Six miles from the ſpot where this ſkeleton was diſcovered we found two entire tuſks, in form exactly like thoſe in the ſkeleton, but very much worn at the extremities (the point of one I have with me), and worn in ſo peculiar a manner, conſidering their form, as could not have happened in an elevated poſition; unleſs on the abſurd ſuppoſition, that the animal amuſed himſelf with wearing and rendering them blunt, by rubbing them againſt high and perpendicular rocks: this in a ſtate of nature can never be ſuppoſed, whatever habits may be acquired when in a narrow confinement. There can be no doubt, then, of their having been *uſed* againſt the ground, and not improbably in tearing up

ſhell-fiſh, if, as we have many reaſons to ſuppoſe, he was of an amphibious nature: for this ſpecies of food his teeth ſeem admirably adapted. All animals of ſimilar habits have ſimilar teeth: this animal has teeth unlike any other with which we are acquainted: there is much reaſon, therefore, in ſuppoſing his food to have been different; eſpecially when we conſider the thickneſs of enamel which covers the teeth, the peculiar manner in which they are worn, and the ſmall opening for the throat. But, whether amphibious or not, in the inverted poſition of the tuſks he could have torn an animal to pieces held beneath his foot, and could have ſtruck down an animal of common ſize, without having his ſight obſtructed, as it certainly would have been in the other poſition.

The tuſks themſelves are compoſed of two very diſtinct ſubſtances: the internal bony or ivory part, which we find in the greateſt ſtate of decay; and a thick, diſtinct coating, doubtleſs having undergone ſome decay, yet at preſent abſolutely heavier and harder than the freſheſt ivory. No part of the ſkeleton is petrified, but all in their preſent ſtate of preſervation from having been ſurrounded by a calcareous ſoil, compoſed principally of decayed ſhells, and covered with water even in the drieſt ſeaſons.

How long ſince theſe animals have exiſted, we ſhall perhaps ever remain in ignorance; as no judgment can be formed from the quantity of vegetable ſoil which has accumulated over their bones. Certain we are, that they exiſted in great abundance, from the number of their remains which are found in America: we are likewiſe ſure that they muſt have been deſtroyed by ſome ſudden and powerful cauſe; and nothing appears more probable than one of thoſe deluges or ſudden irruptions of the ſea, which have left their traces in every part of the globe, and which are in amazing abundance on the very ſpot where theſe bones are found: they conſiſt of petrifactions of ſea productions, ſhells, corals, &c. It is extremely probable that, whenever and by whatever means the extirpation of this tremendous race of animals was effected, the ſame cauſe muſt have operated in the deſtruction of all thoſe inhabitants from whom we might have received ſome ſatisfactory account of them.

Dimenſions of the Skeleton.

	Ft.	In.
Height over the ſhoulders - - -	11	0
Ditto over the hips - - -	9	0
Length from the chin to the rump - -	15	0

From

	Ft.	In.
From the point of the tuſks to the end of the tail, following the curve	31	0
Length in a ſtraight line	17	0
Width of the hips and body	5	8
Length of the under jaw	2	10
Weight of the ſame 63½ pounds		
Width of the head	3	2
Length of the thigh-bone	3	7
Smalleſt circumference of the ſame	1	6
Length of the tibia	2	0
Length of the humerus, or large bone of the fore-leg	2	10
Largeſt circumference of the ſame	3	2½
Smalleſt ditto ditto	1	5
Length of the radius	2	5½
Circumference round the elbow	3	8
Length of the ſcapula, or ſhoulder-blade	3	1
Length of the longeſt vertebra, or back-bone	2	3
Longeſt rib, without cartilage	4	7
Length of the firſt rib	2	0
Ditto of the breaſt-bone	4	0
Length of the tuſks, defences, or horns	10	7
Circumference of one tooth or grinder	1	6½

Weight of the ſame, 4 pounds 10 ounces

The whole ſkeleton weighs about 1000 pounds.

XXVII. *New Theory of the Conſtitution of mixed Gaſes elucidated. By* J. Dalton, *Eſq.**

In an eſſay, publiſhed in the Memoirs of the Literary and Philoſophical Society of Mancheſter, vol. v. part 2, I gave a new theory of the conſtitution of mixed gaſes, and particularly of the atmoſphere, and endeavoured to illuſtrate my meaning by a plate, &c. Notwithſtanding this, I am informed by ſome of my chemical friends that they do not clearly underſtand the hypotheſis itſelf, and conſequently are not able to judge of its merits or defects: and a late writer (Dr. Thomſon) in his Syſtem of Chemiſtry, vol. iii. p. 270, ſpeaking of the uniform diffuſion of the different gaſes of the atmoſphere, makes the following obſervation:—"Even Mr. Dalton's ingenious ſuppoſition, that they neither attract nor repel each other, would not account for this equal diſtribution; for, undoubtedly on that ſuppoſition they would arrange

* Communicated by the Author.

themſelves

themſelves according to their ſpecific gravity." Now, as I am perſuaded that no one acquainted with the principles of mechanical philoſophy could have written the above if he had underſtood my hypotheſis, it ſeems to call from me a further explanation. I propoſe therefore, 1ſt, To ſtate, in as clear a point of view as the ſubject will admit, the principles which I aſſume: 2d, To ſhow that the conſequences which I have deduced from them are legitimate; and, particularly, that mixed elaſtic fluids ought *not* to arrange themſelves according to their ſpecific gravity: and, 3d, To demonſtrate that the ſuppoſition of the gaſes conſtituting the atmoſphere being held in a ſtate of equal diffuſion by chemical affinity, is not only inconſiſtent with the phænomena, but is completely abſurd.

I. *Principles aſſumed.*

1. I take for granted, that the particles of ſimple [unmixed] elaſtic fluids repel one another with forces inverſely as the diſtance of their centres, the temperature being given. This is a mathematical deduction from the allowed fact, that the ſpace occupied by any gas is inverſely as the compreſſing force. (See Newton's *Principia*, b. ii. prop. 23.) The *abſolute* diſtances of the centres of ſuch particles muſt vary according to circumſtances, and cannot eaſily be determined; their *relative* diſtances in a liquid and aërial ſtate ſometimes may. Mr. Watt has ſhown that ſteam of 212°, and preſſure 28 inches, is 1800 times lighter than water; conſequently the diſtances of the particles of ſteam are to the diſtances of the ſaid particles in a liquid ſtate as 12 to 1, nearly, in that particular caſe. Vapour in the vacuum of an air-pump, at common temperature, will have its particles about four times the diſtance, or 48 to 1.

2. I ſuppoſe that in mixed elaſtic fluids the heterogeneous particles do not repel one another at all at ſuch diſtances as they repel thoſe of their own kind; but that ſuch particles, when brought into actual contact (to uſe the common language), reſiſt each other in all reſpects like inelaſtic bodies. This is the peculiarity of the hypotheſis, and what appears not to be generally underſtood. If I may explain by analogy, the moſt ſtriking will be found in magnetiſm. Two like poles of magnets repel one another with the ſame force, whether any other bodies intervene or not, and do not affect thoſe other bodies: in the ſame way I conceive two particles of any one gas repel one another with the ſame force, whether particles of other gaſes intervene or not, and do not affect thoſe other particles. A magnet is amenable to the common laws

of motion in its colliſion with other bodies, and when it is brought into ſeeming contact with them; ſo is a particle of one gas when it is brought into ſeeming contact with a particle of another ſpecies; and in this caſe the bodies may be ſaid to have a repulſive power: but this power is eſſentially different from the other, in that it extends to no definite diſtance. Further, conceive a very fine capillary tube placed perpendicular to the horizon, into which let a number of correſpondent ſmall magnetic wires, or particles, be inſerted, with their poles of the ſame denomination together, or, more ſtrictly, as near as their repulſive power would admit, one particle above another, the air having intercourſe amongſt them. Then, as the magnetic particles would not actually touch one another by reaſon of their repulſion, they would *ſeem* to be ſupported by the intervening air; whereas in reality they are ſupported and kept at certain diſtances entirely by the repulſion inherent in themſelves and their own gravitation: and thus, I conceive, particles of gas ſupport thoſe of their own kind above them, though, were they viſible, they might ſeem to reſt upon others immediately under them; and the ground, or loweſt ſolid or liquid ſurface, by ſupporting the loweſt particle of each kind, has the weight of the whole to ſuſtain. Theſe obſervations, together with a view of the plate above alluded to, muſt, I think, be ſufficient to ſatisfy any one what the hypotheſis is. And it may be proper to add, there is ſomething much reſembling polarity obſervable in the ultimate particles of bodies at the inſtant of tranſition from the liquid to the ſolid ſtate: witneſs the congelation of water.

II. *Conſequences.*

It is plain from the above account that I conceive any one gas to be conſtituted of perhaps *one* part ſolid matter, and *one thouſand* or more parts vacuity or pore, if it may be ſo called; and that into this vacuity we may throw as many other gaſes as we pleaſe without materially diſturbing the firſt, provided we do not abſolutely fill the vacuity with ſolid matter (for ſo I denominate common liquids or ſolids). Thus, we might have had a dozen gaſes in our atmoſphere inſtead of three or four, all in the ſame compaſs, and each retaining the ſame denſity it would have had alone. The heavier gas has no more tendency to raiſe the lighter than a quantity of ſhot has to expel the air from its interſtices. If therefore Dr. Thomſon, or any other, can ſhow how one fluid, which is not diſplaced nor any way acted on by another, ſhould by its *reaction* cauſe that other to move into a higher or lower ſtation, then the mathematical world will be obliged to reconſider their

their doctrine of ſtatics. Till then I muſt take the negative of the propoſition, and conclude that elaſtic fluids of the greateſt and leaſt ſpecific gravity imaginable, on the ſuppoſition I hold, will alike take the loweſt and the higheſt ſtations, regardleſs of each other; or, in other words, they will arrange themſelves in the ſame order as if thrown into a complete vacuum. The great difficulty reſpecting the uniform diffuſion of the gaſes being removed, I think on my hypotheſis the other phænomena can require no explanation to any perſon converſant in pneumatics. I will take one inſtance: it may be aſked, How does ſulphuret of potaſh abſtract oxygenous gas out of any mixture; lime water, carbonic acid gas, &c. &c.? The anſwer is obvious: Exactly in the ſame way as if the gas in queſtion was the only one in the veſſel, and the operation going on in a cloſe veſſel.

III. *Gaſes held together by chemical Affinity abſurd.*

On this head it will be proper to premiſe certain facts:

1ſt, When two gaſes of different ſpecific gravity, ſuch as oxygenous and hydrogenous, are put into the ſame veſſel and agitated; then, after ſtanding ſome time, they ſtill continue uniformly mixed.

2. They occupy the ſame ſpace before and after mixture; that is, *one* meaſure of each put together occupy *two* meaſures, the temperature and preſſure being the ſame. Mr. Davy ſeems to think this principle not ſtrictly true in regard to a mixture of azotic and oxygenous gas; but the deviation from it, if any, is extremely ſmall.

3. The compound is ſubject to the ſame laws of rarefaction and condenſation as the ſimples.

There are but *three* ſuppoſitions we can make eſſentially different reſpecting the mutual action of heterogeneous particles of gas. 1ſt, When two gaſes are mixed, their particles may reciprocally *repel* one another, juſt as they act on their own kind in an unmixed ſtate: 2d, They may be neutral, or have neither attraction nor repulſion for each other: 3d, They may have a chemical affinity or *attraction* for each other. The advocates for the chemical adheſion of gaſes will agree with me in exploding the *firſt*, becauſe, where nothing but *repulſion* is manifeſt, we can aſcribe no effect to attraction: the *ſecond*, which is the one I adopt, is obviouſly inconſiſtent with their hypotheſis: and as for the *third*, I can conceive no other explanation than the following: 1ſt, Two or more heterogeneous particles may unite, and become a new centre for the caloric to adhere to; but in this caſe the gaſes are no

longer *two* but *one*, and oxygenous gas and hydrogenous will become aqueous vapour: this, therefore, would not be a case of two *gases* held together by affinity. 2. Two gases may separately retain their caloric, and still be held by chemical affinity; that is, there may be an equilibrium between the powers of attraction and repulsion: but this is evidently inconsistent with the third law of condensation and rarefaction, observed in such compounds.

Manchester, Nov. 20. J. DALTON.

Note. I have lately read a paper to the Literary and Philosophical Society of Manchester, in which I have shown that the quantity of carbonic acid gas found in a given volume of atmospheric air is not more than $\frac{1}{100}$th part of the whole; and that the said gas is held in water, not by chemical affinity, but merely by the pressure of the gas, abstractedly considered, on the surface, forcing it into the pores of the water.

XXVIII. *Proceedings of Learned Societies.*

ROYAL SOCIETY OF LONDON.

THIS learned body has recommenced its labours by bestowing on count Rumford the first medal awarded from the fund provided by the count himself for discoveries on the nature and properties of heat.

The Copley medal has been adjudged to Dr. Woolaston.

On the first night of meeting, which was on the 11th of November, the Bakerian lecture was delivered by Dr. Woolaston. The subject, horizontal refraction.

On the 18th was read a paper, by Mr. Chenevix, on the chemical properties of the humours of the eye; and one by Mr. Smithson on calamines or ores of zinc.

On the 25th, a paper, by M. Aldini, on the galvo-electricity of hot-blooded as well as cold-blooded animals. The experiments detailed in this curious paper are similar to those of which we gave an account in our last, and to some detailed in a subsequent page of our present number.

FRENCH NATIONAL INSTITUTE.

Account of the labours of the Class of the Mathematical and Physical Sciences during the last quarter of the year 10. —The mathematical part by Lacroix secretary.

ASTRO-

ASTRONOMY.

Calculation of Obſervations of two Occultations of the Spica Virginis by the Moon, which took place in the Year 9—Diſcovery of a new Comet—Obſervations of the Planet diſcovered by Dr. Olbers.

Occultations of the ſtars by the moon are ſo uſeful for improving geography, by determining the longitude, that they have been ranked among the moſt important of the celeſtial phænomena; and in this claſs thoſe eaſieſt to be obſerved, and which give the ſureſt reſults, are occultations of ſtars of the firſt magnitude.

The moon, by the poſition of its orbit, can eclipſe only four; namely, Aldebaran, Regulus, Centares, and the Virgin's Spike; but the paſſage of the latter behind the moon's diſk rarely takes place. C. Lalande knows only four epochs in the ſpace between 1623 and 1790; and the year 9 having exhibited two, he took care to unite and calculate the obſervations which reached him of this phænomenon.

For the firſt occultation, which took place on the 30th of March, theſe obſervations are in number ſixteen, of which the city of Paris alone furniſhed ſix, carefully made by the moſt diſtinguiſhed aſtronomers. It was from an obſervation made by C. Ciccolini, at Florence, that Lalande determined the longitude of that city, which he publiſhed ſome time ago, expreſſing his aſtoniſhment that the poſition of a city of ſo much importance ſhould have hitherto been ſo inaccurately fixed.

The longitude of the moon, deduced from obſervations at the time of the conjunction of theſe two bodies, is leſs by 13″ than that given in the tables lately tranſmitted to the board of longitude by M. Burg.

Fourteen obſervations of the ſecond occultation, which took place on the 24th of May, were examined and calculated with the ſame care as the preceding. On this occaſion there was an obſervation alſo at Florence, the reſult of which gave 6″ more in time in the difference of meridians between that city and Paris, as deduced from the firſt occultation.

The error of the tables of M. de Burg was,

In longitude	- -	+ 4″
In latitude	- -	+ 3

On the 1ſt of September C. Mechain read in the ſame ſitting a notice on the new comet which he diſcovered at the national obſervatory on the evening of the 28th of Auguſt in Serpentarius. It was not viſible by the naked eye: it reſembled two nebulous ſtars which are in the ſame conſtellation a little below the equator, and from which it was diſtant only ſome degrees towards the ſouth. The centre of the nebulo-

ſity

ſity ſeemed a little more luminous than the reſt; but no ſenſible nucleus was diſtinguiſhed, nor any trace of a tail. After that period the light of the comet always decreaſed, becauſe it was removing from the earth. Its apparent motion in declination, which was at firſt $2\frac{1}{2}$ degrees towards the north, in 24 hours, was not more the laſt day than 30 minutes. The motion in right aſcenſion amounted towards the end to no more than 17 minutes in 24 hours. The ſucceſſive decreaſe of the light of the comet, and the brightneſs of the light of the moon, did not allow of its being obſerved any longer. It traverſed the conſtellations of Serpentarius and Hercules.

During the 36 days it was viſible he determined its poſition on 23 different days; and from his own obſervations he calculated the elements of its orbit as follows: they have no reſemblance to thoſe of any of the preceding comets:

Perihelion diſtance 1·0942046; the mean diſtance of the earth from the ſun being ſuppoſed 1·0.

Paſſage of the perihelion Sept. 9, 1802, at 20 h. $43\frac{1}{2}'$ mean time at Paris.

Place of the perihelion in the orbit -	11ˢ	2°	$7\frac{3}{4}'$
Longitude of the aſcending node -	10	10	$16\frac{5}{6}$
Inclination of the orbit - -		57	$0\frac{5}{5}$

Motion—direct.

This comet is the 94th with the elements of the orbits of which we are acquainted, and the thirteenth diſcovered by C. Mechain. It was obſerved on the 26th of Auguſt, or two days before, by C. Pons of Marſeilles; but on theſe two days the ſky at Paris was overcaſt. Dr. Olbers diſcovered it alſo at Bremen on the 2d of September. C. Meſſier, our fellow-labourer, and C. Bouvard, adjunct of the board of longitude, obſerved it with great aſſiduity after the appearance of it had been announced by C. Mechain.

We ſhall give here only four poſitions determined by C. Mechain; the firſt, the laſt, and the two intermediate ones: all the reſt will be publiſhed in detail in the next volume of our memoirs.

Dates.	Mean Time at Paris.	Apparent right Aſcenſion.	Apparent Declination.
Aug. 28, 1802	9ʰ 44′ 30″	249° 19′ 68″	6° 8′ 52″ S
Sept. 5	10 2 14	251 47′ 11	9 41 17 N
Sept. 17	8 31 42	255 3 5	24 18 50
October 3	10 27 5	259 22 57	35 23 39
Apparent motion in 36 days	0 42 35	10 2 59 Towards the Eaſt	41 32 31 Towards the North

The

The planet which we announced in the account of the labours of the laſt quarter, diſcovered by Dr. Olbers, of Bremen, has alſo engaged the attention of all aſtronomers.

It was obſerved by C. Mechain till the 28th of Auguſt, and a ſufficient number of its poſitions was obtained to determine the elements of its orbit in ſuch a manner as to enable us to find it again ſome months hence, when it will appear in the morning after iſſuing from the rays of the ſun. C. Burckhardt, adjunct of the board of longitude, preſented ſome to the claſs, which he calculated, taking into account even the perturbations which this planet experiences from the principal part of the reſt. Theſe elements repreſent very well all the obſervations hitherto made. C. Vidal, director of the obſervatory of Toulouſe, placed under a ſky ſo favourable to aſtronomy, followed the planet of Olbers with the ſame attention and conſtancy which he employed in the obſervations of Mercury, which are ſo difficult; and he ſent to the claſs forty, with a table containing twenty-three ſelect determinations of its right aſcenſion and declination, and a chart of its apparent route from the 19th of May to the 23d of Auguſt.

In this period of time it paſſed over about 17 degrees in right aſcenſion and 5 in declination.

It appeared to C. Vidal as a ſtar of the ninth magnitude, and exhibited no trace of that nebuloſity with which comets are always accompanied.

NATURAL PHILOSOPHY.

Obſervation of a remarkable Phænomenon of Terreſtrial Refraction.

The moſt remarkable of the phyſical phænomena next to thoſe which inſpire moſt men with terror, are thoſe ſingular appearances which are produced ſometimes by the reflection or refraction of parts of the atmoſphere, and towards which the attention of philoſophers has been directed by the obſervations of C. Monge.

This circumſtance reminded C. Dangos of an effect of terreſtrial refraction which he witneſſed at Malta in 1784.

On the 20th of March, about one in the afternoon, he learned, by loud ſhouts, which reſounded from all the ſtreets of the town, that a new iſland had ariſen in the channel of Malta. Having aſcended to one of the terraces of the obſervatory, he indeed obſerved a very white tract of land in the middle of the water, the form of which was nearly that of a right cone irregularly truncated. The illuſion was ſo complete, that ſome of the ſailors had reſolved to go and reconnoitre

connoitre this iſland in order to take poſſeſſion of it. Its figure, colour, and particularly its ſituation, in the line which joins Malta and Mount Ætna, made C. Dangos ſoon perceive that it was nothing elſe than the appearance of the ſummit of that mountain, always covered with ſnow, which ſome extraordinary cauſe had brought conſiderably nearer, lowering it at the ſame time very much below the level of the water.

The publicity of this phænomenon did not permit C. Dangos to obſerve it with more preciſion. A multitude of curious ſpectators, whom he could not get rid of, crowded the terrace. But this aſtoniſhing ſpectacle appeared again on the 17th of April 1785, at ſix in the morning; a time when the indolent, not being awake, could not interrupt the diligent philoſopher in his retreat.

On this occaſion, the apparent iſland, which was better defined than that of 1784, ſeemed to be $15' 17''$ below the horizon, which correſponds to a diſtance of about 18000 yards: it ſeemed then to recede and to riſe up; after which it became confuſed for a moment, and Ætna re-appeared in its real place. The coaſts of Sicily, which had been hitherto concealed, were fully ſeen, and remained viſible during the reſt of the day.

C. Dangos, without attempting to explain this phænomenon, thinks that the humidity of the atmoſphere, of which he that day perceived very ſenſible ſigns, had a great ſhare in it; and that obſervations of the hygrometer ought not only to be added to thoſe of the thermometer and barometer to determine the refrangent force of the atmoſphere, but ſome day may ſupply the place of each other.

Going back to the beginning of the laſt century, we find, in the memoirs of the Academy of Sciences, "that the mountains of Corſica, ſeen from the coaſts of Genoa and Provence, ſeem at certain hours to plunge into the ſea." The author of the memoir which we here analyſe, ſaw the ſame appearance when at the Iſles d'Heyeres in 1778: but this phænomenon was not ſo well defined as that which he relates.

[To be continued.]

ACADEMY OF DIJON.

In the public ſitting on the 6th of September laſt, this ſociety, after adopting the plan of its labour and fixing the nature of its occupations, thought proper to change its title into that of *Academy of the Sciences, Arts, and Belles-Lettres.* It was of opinion that this denomination, more general and

more expressive, would preserve much better the remembrance of that illustrious association to which it has succeeded, and in whose steps it proposes to tread.

C. Lesebevin read a report on the discovery of the phænomenon of scintillation by the collision of charred wood. Three successive explosions took place in the course of four months in the powder manufactory of Vonges, notwithstanding all the precautions employed to avoid them. The frequent return of these events induced government to send to the spot C. Lemaitre, inspector-general, to inquire into the cause of these accidents. Having assured himself that no part of the machinery was deranged, and that no foreign substance had been introduced into the mortars, he endeavoured to verify the suspicions entertained in regard to the employment of charcoal in sticks. He recollected, that under certain circumstances he had obtained sparks by the collision of charred wood: he therefore made a trial, and, after three or four strokes, excited three strong sparks. This fact serves to account for the explosions; it explains why they do not happen more frequently, and points out in what manner explosions may be totally prevented, by adding one caution more to those already employed, namely, to pulverize the charcoal used in the manufactory of gunpowder *. C. Leschevin terminates his memoir with the following reflection:—"Heat and light disengaged from a combustible body being the more abundant as the combination of oxygen with the body is stronger in a given space of time, it seems to result from the different circumstances of the phænomenon I have described, that a very slight degree of heat only is required to effect the combination of oxygen with charcoal, and the combustion of the latter."

C. Potel, in a memoir on bleaching, communicated to the society interesting details respecting the new method substituted for the old one for bleaching linen, &c. He examined the different agents which have been recommended for some years past; gave an account of the result of the experiments he tried to ascertain the value of each of them; and concluded his memoir by pointing out the most advantageous; such as *odorous oxygenated muriatic acid* and *caustic alkali in vapour*, which are those employed in his establishment. He showed that the use of *sulphuret of lime* without any mixture is absolutely improper for bleaching; and how ill-founded is the fear of those who reject the new

* In most of the gunpowder manufactories in England, if not in all of them, the practice, we believe, has long been to pulverize the charcoal alone: yet explosions still take place.—EDITOR.

process

proceſs becauſe they ſay it *burns the cloth*. He proved that if the operation is performed by an intelligent and careful artiſt, the cloth gains inſtead of loſing. The author acknowledges that in theſe different proceſſes the agent is always the ſame, namely, *oxygen*, which combining with the colouring principle renders it ſoluble in the leys employed, which then become much more effectual.

The uſe which C. Potel made of *oxygenated muriatic acid gas* conducted him by accident to many trials and experiments which are of the utmoſt importance. He has diſcovered that this ſubſtance may be employed with the greateſt advantage in all caſes of *aſphyxia*. Several rats which had been found drowned, were placed on a table on which ſome of this gas was depoſited: ſoon after the rats diſappeared, and concealed themſelves in a corner of the room, except one which remained in the neighbourhood of the apparatus: it had been reſtored to life, but, having ſuſtained ſome injury in its feet, it was not able to follow the reſt. C. Potel caught theſe animals, reduced them again to a ſtate of aſphyxia, and, having ſubjected them to the action of the gas, ſaw them reſuſcitated before him. He repeated the experiment with the ſame ſucceſs in cats: in the laſt place, in imitation of Dr. Storch, who tried on himſelf the action of hemlock, this young chemiſt was induced to try on himſelf the efficacy of his new method, and his boldneſs was crowned with ſucceſs. The academy has appointed commiſſioners to aſcertain in a certain manner the property of this gas in caſes of aſphyxia.

C. Degouvenain gave the reſult of a great number of experiments he made on acetous fermentation, and which led to the demonſtration of two points in theory not before proved by any poſitive fact; one of which, when the author publiſhes his proceſſes, will ſerve as a guide to thoſe deſirous of making good vinegar. In the mean time he has applied his diſcovery to the advantage of domeſtic economy; and being convinced that the efficacy of aromatic vinegar depends much more on its acid nature than the aromatous ſubſtances with which it is accompanied, he made ſome which to be ſaturated required from 130 to 150 parts of potaſh in a thouſand, whereas the ſtrongeſt before known (that of Maille) abſorbs only 114.

Good wine combined with oxygen by a ſeries of ingenious proceſſes peculiar to himſelf, is the only ſubſtance he employs for making vinegar; and the reſult, according to the report of the commiſſioners of the academy appointed to examine it, is, that it is in every reſpect ſuperior in quality to the moſt

celebrated hitherto known. This vinegar may be carried to any country, and will keep any time without fear of alteration. It poſſeſſes alſo another advantage, which is, that it coſts only half as much as that known under the name of Maille.

XXIX. *Intelligence and Miſcellaneous Articles.*

VACCINE INOCULATION.

Dr. Pearſon's ſecond and laſt Evidence.

Mercurii, 14 Aprilis, 1802.

Admiral BERKELEY in the Chair.

DR. PEARSON was called in and examined, and ſtated, that Dr. Heberden * authorized him to ſtate, on the authority of Dr. Lind, and Mr. Battiſcombe of Windſor, that there is now living near Windſor a perſon (the ſon of an apothecary,) who many years ago was inoculated for the cow-pox.

Did Dr. Heberden inform you whether this inoculation was performed from one human being to another, or from the virus taken immediately from the cow?

A. This is a queſtion I cannot anſwer.

What further facts do you know affecting Dr. Jenner's claim of being the promulgator, or inventor of vaccine inoculation?

A. I have admitted Dr. Jenner was the gentleman who firſt ſet on foot the inquiry into the advantages of the vaccine inoculation; but I apprehend that the practice of vaccine inoculation, which was firſt promulgated by Dr. Jenner, has been eſtabliſhed almoſt entirely by other practitioners, and that his new facts, or what I conſider to be new, have been, in my opinion, diſproved by ſubſequent obſervers; and that in conſequence of thoſe facts being diſproved, together with the very extenſive experience of other perſons, we owe the preſent practice of the vaccine inoculation.

Will you inform the committee who thoſe practitioners and perſons were to whom you refer?

A. The cow-pock inoculation, after Dr. Jenner's book was publiſhed in May or June 1798, which contained ſeven or eight caſes, (the whole reſult of his experience,) was not practiſed by any perſon, that I know of, till January 1799; neither Dr. Jenner, nor any other perſon that I could find, being in poſſeſſion of matter: but in January 1799, in con-

* See Dr. Heberden's Evidence, annexed to this of Dr. Pearſon.

ſequence

ſequence of a general inquiry, which I had inſtituted immediately after Dr. Jenner's publication, information was given of the cow-pock diſeaſe breaking out in two of the cow ſtables near London; and from theſe ſources Dr. Woodville and myſelf collected matter, by which, in the courſe of about three months, not fewer, I think, than about 300 perſons were inoculated, in addition to the ſeven or eight caſes of Dr. Jenner, then the whole ſtock of facts of inoculation before the public. Beſides carrying on the inoculation ourſelves in this manner, we diſſeminated the matter throughout the country, in particular to Dr. Jenner* himſelf; and particularly alſo, I within that time iſſued a printed letter, directed to upwards of 200 practitioners in different parts of the kingdom, containing thread impregnated with cow-pock matter. In the courſe of this practice we already learnt that young infants might be inoculated with ſafety; which I conſidered to be then a new fact, Dr. Jenner not having had the experience, and being apprehenſive of ſerious † conſequences from inoculating them.

Secondly, That the inoculated arms, ſo far from requiring cauſtic or eſcharotic, or other topical applications, according to Dr. J., were ſooner cured than in the inoculated ſmall-pox: That Dr. Woodville's publication, in June 1799, appeared, containing the caſes of upwards of 400 inoculated, up to that time: and in Auguſt 1799 I publiſhed a ſtatement of inoculation, referring to many practitioners who had furniſhed me with reports of inoculation with matter which I myſelf had furniſhed: among theſe I beg leave to mention Mr. Relſon, of Seven Oaks; Dr. Mitchel, of Chatham; and Dr. Harriſon's caſes; as communicated to me by the right honourable ſir Joſeph Banks: and by that time I had alſo introduced it into the army, through the hands of the ſurgeon-general, Mr. Keate; and reports frequently came into my hands, by his direction, from the army. I had alſo by that time introduced the vaccine inoculation into many parts of the continent, and received reports of the ſucceſsful practice of it; in particular, from Dr. De Carro, of Vienna. In addition to theſe teſtimonies contained in the paper above alluded to, is the reſult of my own practice in three pariſhes of poor people inoculated under my ſuperintendance; ſo that in that paper, I be-

* See Dr. Jenner's Letter in Dr. Pearſon's Inquiry 1798, in which he ſays no matter can be had. Dr. Jenner, both in letters to Dr. Woodville and Dr. Pearſon, owns this matter excited the genuine cow-pock.—*Note of the Evidence.*

† This is alſo acknowledged in Dr. Jenner's Letter to the Evidence in February 1799.

lieve, it will be found that 2000 cafes had by that time been afforded for the public by Dr. Woodville and myfelf, and the perfons with whom I was in correfpondence, and who are mentioned in the papers alluded to. By this time, too, fome difficulties appear to have been removed which had been occafioned, in a great meafure, by fome facts ftated to the public by Dr. Jenner. In particular, I publifhed experiments of inoculation in the paper alluded to:—1ft, Of inoculating perfons with the cow-pock who had undergone the fmall-pox, to fhow that they could not take the cow-pock after the fmall-pox, contrary to Dr. Jenner: 2dly, Experiments to fhow that perfons could not take the cow-pock both locally and conftitutionally who had already gone through the cow-pock, alfo contrary to Dr. Jenner: 3dly, Many perfons had by this time made experiments to fhow that the cow-pock did not originate in the greafe of horfes' heels, as Dr. Jenner had afferted. Thefe fentiments will be found in a printed ftatement, which I beg to deliver in as publifhed by me.

In the fpring of the year 1799, whilft the above-ftated evidence was collecting, a fecond publication appeared from Dr. Jenner, adding nothing but a few cafes of inoculation further of the cow-pock, but recommending cauftic or efcharotic applications to the inoculated parts in the cow-pock, not found neceffary by myfelf or the medical perfons alluded to in my evidence: and I confider that the diftinctive characters of the cow-pock were underftood better by fome of the above alluded to perfons than by Dr. Jenner.

The vaccine inoculation was next confiderably eftablifhed by the Cow-pock Inftitution, of which I was one of the founders, the arrangement for which commenced at the very clofe of the year 1799; which Inftitution has been the principal office, I apprehend, for fupplying the world in general, and the army and navy in particular, with matter; and where a regular regifter is kept of each of the cafes inoculated, more fully and accurately than had been done any where before or fince that time; where the authenticity of the cafes, from the nature of the inftitution, is eftablifhed in a manner that, I apprehend, will be confidered as unexceptionable. This appears from a regifter of above 700 cafes already entered, and open to the infpection of the fubfcribers. By this time, namely, the clofe of the year 1799, I think I can make it appear that about 4000 perfons have been inoculated by Dr. Woodville, myfelf, and correfpondents, which can be referred to. I here clofe my evidence, as I confider it of very fmall importance, comparatively, what was done by others after this

this time, all the facts that I recollect of use in practice being by this time established, as they have been since confirmed.

Did you never hear of inoculation having been performed by Mr. Cline*, with matter furnished by Dr. Jenner, previous to the time you began to practise vaccine inoculation?

A. I cannot recollect distinctly.

Were not seven or eight cases of Dr. Jenner alluded to by you, cases of inoculation from one human being to another?

A. Some of them were; some were not.

Had not many, or a large majority of your first cases, variolous-like eruptions?

A. The matter, which had never been in the Small-pox hospital, and which I myself took from the cows at the two cow stables above alluded to, scarcely ever afforded any eruptions like the small-pox; but when I obtained matter to supply my correspondents in the country, not having enough of my own, but obtaining it from the Small-pox hospital, it frequently, according to the reports of my correspondents, and in a few cases where I used it myself, did produce such eruptions.

Was not the matter, or virus, which you distributed, found great fault with on account of the eruptions it produced?

A. No, it was not found fault with; but many people were disappointed, as they expected that one of the advantages attending the inoculation was to be exempt from the eruptions.

Did not these eruptions, which were produced by your matter, very much discourage practitioners and the public, and very much retard the progress of the new inoculation?

A. I should think it did not.

Do you not know there is a case in Dr. Jenner's† first publication of his having inoculated a child of eleven months old?

A. I believe there is one case.

Did not Dr. Woodville and yourself take the vaccine matter in Gray's-inn Lane, for the purpose of commencing your experiments, from a person fully marked with the small-pox?

A. No such case is in my recollection.

Have those facts stated by you to militate against Dr. Jenner's declared opinions remained uncontradicted by him? Does he still maintain them, or has he publicly retracted them?

A. I think he has not retracted them. [Withdrew.

* The Evidence afterwards found there had been a single case, but from which no one had any benefit by matter, nor was it published till the following year.

† See note, p. 181, on the inoculation of infants.

Dr. Heberden's Evidence.

Dr. Heberden, being called to ſpeak to the ſtatement made as above written, ſaid, "That all he knew upon the ſubject was, about three years ago Dr. Lind, of Windſor, mentioned to him, in converſation, there was living, near Windſor, a young man, apprentice to an apothecary, who, when a child, was inoculated with vaccine matter by his father, who was an apothecary in the weſt of England. With reſpect to Mr. Battiſcombe he could not ſpeak, having heard nothing of it." —On this extract, from the minutes of the committee of the houſe of commons, the following remarks have been publiſhed: "In his (Dr. Pearſon's) examination of the 14th (April) the authority of Dr. Heberden is made uſe of to prove what on that gentleman's examination *was found completely erroneous, for he could not ſpeak to what Dr. Pearſon aſſerted he could*; *and of Mr. Battiſcombe he had no knowledge.* On this it is unneceſſary to make any comment; the concluſion muſt be obvious."

Theſe aſſertions, made from the words of Dr. Heberden's evidence, muſt appear unwarrantable by merely publiſhing this gentleman's explanation ſubjoined, obligingly communicated at the requeſt of Dr. Pearſon, who is conſcious that he had been ſufficiently correct in the ſtatement above given on the authority of Dr. Heberden.

"Dr. Heberden acquieſces in the correctneſs of his printed evidence, with the addition of only two words, viz. "having heard nothing of it *from him.*" In fact, Dr. Heberden was acquainted with Mr. Battiſcombe, but received his information reſpecting the vaccine inoculation from another quarter. Still it is true, that when Dr. Heberden mentioned the circumſtance to Dr. Pearſon upon Dr. Lind's authority, he corroborated his ſtatement by adding, that Dr. Giſborne had been made acquainted with the ſame account through Mr. Battiſcombe. So that Dr. Heberden may, in effect, be ſaid to have related the circumſtance to Dr. Pearſon upon the united teſtimony of Dr. Lind and Mr. Battiſcombe; though, his information in the latter caſe not having been derived *immediately* from that gentleman, he could not, with propriety, produce to the committee the authority of Mr. Battiſcombe for what he had heard upon the ſubject."

How to inoculate ſeveral hundred Perſons with the Matter of a ſingle ordinary Vaccine Pock.

A member of the Vaccine Inſtitution mixed the fluid of a ſingle cow-pock with a drachm meaſure of water of about

the

the temperature of 70° of Fahrenheit. Of *three* subjects inoculated with this diluted matter, two took the disease in the usual way. The remaining third was inoculated in each arm with one puncture with this diluted matter, and also in each arm, in like manner, with undiluted cow-pock matter; but all these four punctures failed to produce the vaccine disease, the subject being an adult, and probably had had the small-pox.

Letters from Bassora of the 17th of June, from S. Mairesty, the British consul at that place, and Dr. Milne, physician to the factory, addressed to Dr. De Carro, of Vienna, confirm the happy result of the vaccine inoculation, which has been introduced into several parts of the East by the zeal of Dr. Carro. This beneficial practice has been introduced not only at Bagdad but also at Bassora. At the latter the consul set the first example by causing his own son to be inoculated; and from the end of April to the 17th of June the operation had been performed on forty subjects with the best success. Dr. Milne inoculated not only the sailors on board some ships destined for Bombay, but supplied a merchant who was travelling to Muscate with vaccine matter for that district.

THE PLANET OF OLBERS.

Circumstances have been much more favourable for determining the orbit of this planet than for that of Piazzi, an arc four times as large. A great number of observations made during six months, with great exactness, notwithstanding the difficulty of observing so faint an object, and an inclination of orbit much more considerable, give more precision to the results of calculation.

C. Mechain and Messier observed this planet till the middle of the month of August; the former, with a telescope which was not even mounted on a parallactic machine, which greatly increases the difficulty of observation. The comet which C. Mechain then discovered having obliged him to interrupt his observations, C. Messier continued to observe it alone till the 24th of September: he even tried to observe it on the 16th of October; but the vicinity of the horizon, and particularly the smoke of the chimneys which surrounded the observatory, rendered the observation too uncertain to be turned to any use. All these observations agree with an uncommon precision, and far superior to what could have been expected from an equatorial sector; C. Lalande having found the difference of 30″ in two consecutive observations of Mercury made with a large equatorial sector by an able astronomer: it appears also that this planet has no where been observed so long as at Paris.

I have

I have again carefully calculated the perturbations of the new planet. They are exceedingly numerous; nevertheleſs I have obtained only an approximation very far diſtant from that perfection to which aſtronomers aſpire. The application of ſo many equations to calculation is attended with ſeveral difficulties, and requires many trials, principally on account of the great inequality. I have not yet finiſhed them, but I hope it will be a gratification to aſtronomers to be made acquainted with the primitive orbit which I had calculated without employing perturbations, and corrected according to the lateſt obſervations; a labour which was interrupted only for two days by the reſearches. I began employing the perturbations—

Node 172° 27′ 35″—inclination 34° 38′ 0″—longitude of the perihelium 121° 12′ 19″: on the 4th of April 1802, its motion + 2·3″ per day.

Mean anomaly, April 4th, at 10h. 51′ 17″, 42° 21′ 9″.

Great ſemi-axis 2·769915; eccentricity 0·2463.

Sidereal revolution 1683 days 20 hours.

Theſe elements repreſent the five obſervations in the following manner:

Errors	Apr. 4.	May 20.	July 2.	Aug. 5.	Sep. 20.
Helioc. in long.	+ 1·4″	+ 1·0″	− 1·6″	− 0·6″	− 6·0″
——— in lat.	0·0	− 2·7	− 3·5	+ 13·5	− 18·3
Geoc. in lat.	-	-	-	+ 11	− 12

Obſervers—Von Zach, Lefrançais-Mechain, Mechain, Meſſier, and Burckhardt.

With theſe elements it is found that the planet on the 4th of Feb. 1803, at midnight, will have 267° 41′ right aſcenſion, and 5° 38′ north declination; which differs only a few minutes from the poſition which Dr. Gauſs deduced from his elements. That able aſtronomer could employ obſervations only to the 8th of July, and ſtill propoſes to rectify his elements by later obſervations.

I hope this reſult will be confirmed when I have determined an ellipſe by employing the perturbations.

BURCKHARDT,
of the Bureau of Longitude.

Nov. 13, 1802.

TRANSIT OF MERCURY OVER THE SUN.

The weather on the 9th of November was favourable to the wiſhes of aſtronomers, who had an excellent opportunity of obſerving this phænomenon. For the information of our philoſophical readers we preſent them with thoſe obſervations of the tranſit which have reached us. In a future number we ſhall give other details reſpecting it.

Utrecht,

Utrecht, Nov. 10.—M. van Utenhoven obſerved yeſterday at the obſervatory of this academy, the ingreſs of Mercury at 12 hours 17 minutes 53 ſeconds, and the egreſs or the end of the tranſit of the planet over the ſun's diſk at 12 hours 19 minutes 28 ſeconds true time. M. Timmers of Rotterdam, a ſtudent here, obſerved the paſſage of Mercury over the meridian to be 15 ſeconds after the ſun's limb. He obſerved alſo ſeveral times the contact of the Sun and Mercury on the horizontal and vertical threads of a quadrant by Bird, in order to calculate the time of the conjunction according to the method of L'Iſle le Cadet. This phænomenon, which will not be viſible again in this republic till the 4th of May 1832, was rendered much more important by the appearance of a great many ſolar ſpots; a collection of ſuch ſpots, one or two of which ſeemed to be larger than Mercury.

Leyden, Nov. 10.—Yeſterday morning I had the ſatisfaction, with M. Biſdom, M. van der Meer, and ſeveral of my pupils, to obſerve at the obſervatory of our univerſity the paſſage of Mercury over the ſun's diſk. Mercury it appears muſt have been on the ſun's diſk before ſun-riſe, as the clouds prevented us from ſeeing that luminary till half after nine. The ſun having then broke through the clouds for ſome time, the planet was plainly ſeen on the ſun's diſk as a black, round, ſharply defined body, and could be eaſily diſtinguiſhed from the ſolar ſpots, a great many of which were then viſible on the ſun's diſk. The planet took its courſe under a great many of the principal ſpots, and, when it approached the ſun's limb, ſeemed to have a ſomewhat elongated form. I obſerved the contact at the time of ingreſs to be at 12 hours 15 minutes 6 ſeconds, and at the time of egreſs at 12 hours 16 minutes 40 ſeconds, and therefore that of the planet's was 12 hours 15 minutes 53 ſeconds, true civil time. The planet employed 94 ſeconds from the time of ingreſs to that of its egreſs, which agrees very well with calculation if the diameter be taken at 11 ſeconds. I previouſly obſerved the planet's paſſage of the meridian with our meridian circle on the 8th of November, 23 hours 43 minutes 8 ſeconds mean time. I have no doubt that this tranſit will enable aſtronomers to improve or confirm the tables of Mercury.

VAN BEECK CALKOEN.

Enſchede, Nov. 13.—Obſervation of the tranſit of Mercury over the ſun's diſk at Enſchede on the 4th of November 1802, with the day teleſcope and an achromatic teleſcope, which magnifies the diameter 50 times, the clock being brought to true time by a meridian line: but there

was

was no opportunity for taking correſponding altitudes of the ſun.

Enſchede lies 50° 16′ north latitude and 7′30″ in time eaſt from Amſterdam. At ſun-riſe I ſaw the planet a good way from the eaſtern limb on the ſun's diſk. There were a great many ſpots on the ſun's diſk, and particularly on the weſt ſide, about 10 in the morning. The ſky was clearer, though it was cloudy in the weſt. We were, however, able to follow the planet in its paſſage. About 11 the ſky became clear in the ſouth; but about 10 minutes after noon a very thick cloud proceeded from the north, which threatened to deprive us of all hope of ſeeing the egreſs. A few minutes before the planet came in contact with the ſun's limb, I took the ſmoked glaſs from the teleſcope, and ſaw clearly the interior contact of the ſun's limb, at 12 hours 22 minutes 10 ſeconds true time; but in a few minutes the weſtern limb of the ſun was covered by a thick cloud, ſo that no obſervation could be made of the exterior contact of Mercury with the ſun's limb.

The planet when on the diſk ſeemed to be ſurrounded by a ſmall luminous circle. The ſun's limb alſo at the time of interior contact ſeemed to quiver, and, as it were, to ſwell up a little. L. Nieuwenhuis.

Paris, Nov. 9.—The paſſage of Mercury over the ſun's diſk was obſerved this morning, for the 19th time. The weather was exceedingly favourable, and aſtronomers enjoyed, in the completeſt manner, the ſight of this curious phænomenon. I was the more anxious to have a view of it, as I ſhall never ſee it more, ſince the next will not take place till the 5th of May 1832; for I do not reckon thoſe which will be inviſible in Europe. I had the ſatisfaction of obſerving it in the ſame place where it was obſerved for the firſt time, Nov. 7th, 1631, by Gaſſendi, one of my moſt illuſtrious predeceſſors in the *Collége de France*. Mercury emerged from the ſun at 8 minutes paſt noon, which agrees to a minute with my tables of Mercury, on which I have been employed for forty years. That day, remarkable to aſtronomers, is much more ſo on account of the regeneration of France. Lalande.

From a Correſpondent.

SIR,

If the ſubjoined ſketch and account of Mercury's tranſit on the 9th inſtant, and his contact with the penumbra, or light part of the largeſt ſpot on the ſun that day, be worth inſerting in your valuable Magazine, the inſertion may perhaps

lead to further diſquiſition, and will much oblige a lover of aſtronomy, who is a conſtant reader of your Philoſophical Magazine *.

Apparent Time.

Firſt contact with the light part at *a* -	11h	2m	50s
Central contact - - -	11	4	24
End of contact - - -	11	5	22
Firſt contact of Mercury with the ſun's limb	11	57	13
Central contact - - -	11	57	54
End of contact - - -	11	58	17

Mr. Tilloch.

From another Correſpondent.

Nov. 8, 1802.—At 20h. 15′ apparent time, having fitted a priſmatic dark glaſs to an achromatic teleſcope of Dollond's, magnifying about 65 or 70 times, I ſaw Mercury upon the ſun's diſk, extremely diſtinct, and well defined. As Mercury was then approaching very faſt towards the ſun's centre,

* This correſpondent is requeſted to furniſh us with the longitude and latitude of his obſervatory, the method by which he aſcertained his time, and the nature and power of the teleſcope he made uſe of.

and

and the body of the sun appearing pretty steady, I began to take some distances with a micrometer I had previously applied to the telescope for that purpose. Upon trial, however, I found the sun's limb so very tremulous, that I could take but few measures so satisfactorily as I wished: those which I can chiefly depend upon, I have here selected and reduced, by which it appears the nearest approach of Mercury to the sun's centre, was at 21h. 13′ 38″ apparent time, when Mercury's centre was 59·8″ north of the sun's centre.

Apparent Time.	Dist. Centres. ☉ & ☿
20h 56′ 2·6″	1′ 58·6″
21 6 10·9	1 11·1
21 8 25·5	1 4·9
21 39 50·2	2 40·7
21 45 29·2	3 15·2
21 46 16·3	3 19·0
21 50 3·5	3 40.4

Internal contact - at 23h 56′ 58″
External contact - at 23 58 35·1
} apparent time.

The above times and observed distances are reduced to the meridian of St. Paul's church, latitude 51° 30′ 49″, long. 23·1″ west.

The internal contact was also observed in long. 19·24″, west lat. 51° 31′ 7″ at 23h. 57′ 18·8″, which reduced to the time of my observation gives 23h. 57′ 12·9″ apparent time. The gentleman who made this observation informs me that the house in which he was situated was in such a continual shake from carriages passing by, that he could not be certain of the contact to less than a few seconds; also that the method by which he got his time was by equal altitudes taken under the like disagreeable circumstances.

TO THE EDITOR.

Respected Friend,

I must beg room for a few lines to obviate any offence to a respectable body by the erroneous addition of F. L. S. to my name, which I meet with in p. 55 of last Magazine. I am neither fellow nor associate of the Linnæan Society, and, notwithstanding the insertion of a little piece, which has been favourably received by that body in their last volume of Transactions, am not, nor have been, a candidate for a place therein. Thy sincere Friend,

L. Howard.

We are sorry to have made the mistake alluded to by Mr. Howard. It arose from a very natural association of ideas,

ideas, which might eaſily miſlead.—His partner in buſineſs Mr. Allan, is a worthy member, and himſelf a meritorious contributor to the labours of the Linnæan Society.

GALVANISM. Paris, Oct. 14.

C. Aldini, a native of Italy, and nephew of the celebrated Galvani, to whom we are indebted for the diſcovery of that electricity called the Galvanic, repeated, a few days ago, in preſence of the commiſſioners of the National Inſtitute, and yeſterday at the Oratoire, in preſence of the Galvanic Society, the principal experiments; in conſequence of which he aſſerts, with juſtice, that the ideas of his uncle reſpecting animal electricity ought not to be entirely rejected, to adopt excluſively thoſe of Volta reſpecting metallic electricity. It reſults, indeed, from the experiments of C. Aldini, that there is an animal pile and an animal circle, as there is a metallic pile and metallic circle.

The experiments of which we were witneſſes, and which prove his opinion in a rigorous manner, are as follow:

1ſt, The ſciatic nerves of a frog being laid bare, as is uſually done, for ſubjecting them to the action of the arming and metallic circle, he contented himſelf with bringing together and putting in contact the muſcular parts of the thighs and paws of the frog with the uncovered nerves, and contractions of the animal took place as in the uſual Galvanic experiment.

2d, He took the frog by the paws, holding it with one hand by the muſcular parts, making the nerves hang down: he touched with a finger of the other hand the nerves thus ſuſpended; and the contractions took place as by the metallic circle and Galvanic apparatus.

3d, For the third experiment, he made his aſſiſtant hold the frog by the paws or by the muſcular parts; applied his finger to the nerves, without giving his hand to the aſſiſtant; and the contractions did not take place. He then gave his hand to the aſſiſtant; and, having applied a finger of the other hand to the nerves, the contractions took place as in the other experiments. Theſe experiments were repeated on ſeveral frogs.

In the laſt place, ſeveral experiments were made on the head of a large dog ſeparated from the trunk, which had no relation either to the animal circle or pile; but afterwards they took one of the above frogs, and, by putting a finger into the ſpinal marrow of the dog, preſenting with the other hand the nerves of the frog to one of the muſcles of the trunk

of the dog, the contractions of the frog took place as with the Galvanic apparatus; which, according to the observations of the author, leaves no doubt respecting the existence of the animal circle and pile. These ingenious experiments will doubtless furnish to their modest and learned author a multitude of other ideas on the animal economy, particularly respecting the nervous fluid, &c., which leave him the care and glory to explain.

For my part, I came out from these experiments charmed and transported with admiration at the simplicity of the means which nature employs in its phænomena that seem to us the most complex. It appears to me proved, that to perform a prodigious number of its operations it contents itself with one electric fluid, which it puts in motion at the surface and in the interior of the earth by a kind of Galvanic piles, which produce, as I have explained in my lectures, a great number of the phænomena of the animal and vegetable kingdom; and that it has employed the same agent in the animal kingdom, by organizing the nerves and muscles as Galvanic piles to execute most of the operations of animal life by the same agent, and by means of these substances the nerves and the muscles, which it has organized in such a manner, that they discharge, in regard to each other, the same functions as the different metals the contact of which excites a permanent current of the electric fluid; which is the most valuable discovery for which we are indebted to the pile of Volta.

It had hitherto been tried, without success, to excite a permanent electric current without friction; and the machine of Hierne did not accomplish this end in a satisfactory manner.

This permanence of the electric fluid, for which we are indebted to the Voltaic pile, is a discovery, then, no less admirable perhaps than that of C. Aldini; and both have given to the natural sciences a stimulus which will astonish future ages, if the results be followed, as there is no reason to doubt.

MASUYER-DIN, Professor in the
Special School of Medicine at Strasburgh.

XXX. *On Capillary Action.* By JOHN LESLIE, *Esq.**

THE principle of univerſal attraction, having finally ſubdued every ſpecies of oppoſition, is now fixed on a baſe never to be ſhaken. Many are the fruitleſs attempts to explain its operation by the impulſive energy of ſome inviſible impalpable fluid: but theſe owe their birth to metaphyſical prejudice, and are juſtly diſcarded by all ſober and reflecting inquirers. Nor is the ſuppoſition of ſuch mechanical *intermedia* merely repugnant to the ſpirit of true philoſophy; it is directly contradicted by recent diſcoveries. When an impulſe is communicated to any maſs or ſyſtem of particles, it is transferred along the chain by a ſeries of pulſations, each particle in ſucceſſion feeling the action and ſuffering a momentary derangement. Motion is therefore propagated in the ſame manner as ſound, and the celerity of its tranſmiſſion muſt depend on the mutual diſtance of the affected particles and the relative force with which they are connected together. In moſt caſes, indeed, that come under obſervation, it is impoſſible to diſtinguiſh the interval between the origin and the termination of an impulſe, which is thence very generally imagined to act ſimultaneouſly through the whole line of its communication. But, though the rapidity of tranſit outſtrips the quickneſs of our ſenſations, it ſtill requires a certain lapſe of time. Nay, on the juſt eſtimate of this principle,—on the duration of effect,—(refined as it may appear,) depends the theory of the tools and manipulations uſed in moſt of the mechanic arts. Nor is the exiſtence of ſuch a ſmall yet finite moment a mere abſtraction; it is the neceſſary reſult of the known properties of matter. Were we to ſuppoſe that the ſun acts on the planets by the intervention of ſome ſubtle medium diffuſed through the celeſtial ſpaces and endowed with the moſt powerful elaſticity, a very conſiderable meaſure of time would be required to propagate the impreſſion. If we aſcribed to that fluid, for example, the relative denſity and elaſticity of hydrogenous gas, almoſt five years would be ſpent in conveying the impulſive energy to the earth. But it is proved, by ſome late and very nice reſearches of M. Laplace on the irregularities of the planetary motions, that the attractive force of the ſun is exerted ſimultaneouſly at all diſtances. The notion of an intermediate fluid is thus entirely precluded.

The principle of *action at a diſtance* is therefore a primary

* Communicated by the Author.

and eſſential law of nature. Gravitation itſelf is only a branch of that law, from which are derived the various conſtitution and all the diverſified properties, of bodies. The mutual action exerted between two elementary portions of matter is, in the language of modern algebraiſts, always ſome *function* of their diſtance. At proximate diſtances, this function muſt change repeatedly, and with different degrees of intenſity, from poſitive to negative, or from attraction to repulſion. Hence the varied ſtructure and compoſition of bodies. It is indifferent whether we conſider the elementary portions of matter as points, atoms, particles, or molecules. Their magnitude, if they have any, never enters into the eſtimate. When the diſtance is conſiderable, the law of action becomes confounded with that of gravitation, and is of ſuch remarkable ſimplicity as to qualify it for the happieſt application ever made of the mathematical ſciences. Could we aſcertain the gradations at near diſtances, we might determine the ſtructure, affinities, and mutual operations of bodies, with the ſame certainty as we compute the revolutions of the planets. But ſuch a diſcovery ſeems placed beyond the reach of the human faculties. However, by a ſcrupulous attention, we may diſcern certain inſtances of the approximation and tranſition of corpuſcular forces. And I hold thoſe facts to be the more valuable, as they form the intermediate link between the mechanical and the chemical phænomena.

Of this kind I conſider the *aſcenſion of water and other liquids in capillary tubes*. This fact is ſo familiar that I need not ſtop to deſcribe it. It was firſt noticed by the Academy *del Cimento*, at Florence, early in the 17th century; but ſeems not to have been much regarded in the ſequel. After the promulgation, however, of the Newtonian ſyſtem, the ſubject was revived with ardour. It was juſtly conſidered as affording intuitive evidence of the reality of attraction. About the beginning of the 18th century, Hawkſbee, in England, made ſome excellent experiments on capillary action; and Muſſchenbroeck purſued the ſame courſe in Holland. Similar experiments were performed in France; but in that country the Carteſian philoſophy was then in the height of its career, and no deliberate attention could be paid to facts which appeared to countenance an oppoſite ſyſtem. About the ſame period Dr. Jurin publiſhed, at London, an elaborate diſſertation on the cauſe of capillary action; and his explication of that curious fact ſeems, either from conviction or ſupine acquieſcence, to be almoſt univerſally adopted. It is repeated in all the elementary books of natural philoſophy. It continues to maintain the ſame credit: no ſuſpicion is ever ſtarted

of

of its ſolidity, and ſcarce an attempt is made to eſtabliſh another theory. The celebrated Clairaut, indeed, has caſually touched on the ſubject of capillary action in his Treatiſe on the Figure of the Earth; but his inveſtigation of that phænomenon is loſt in a chaos of calculation. M. Lalande, who is ſo active a writer, has tried to unravel it: the aſtronomer does not appear, however, to have ſucceeded. I content myſelf with this general notice of his little tract; for to refute it is much eaſier than to render it diſtinctly intelligible.

But, when we coolly conſider Jurin's account of capillary action, we are ſurpriſed that it could obtain ſuch ſucceſs. It is in appearance ſimple indeed, and plauſible; but it will not bear the ſlighteſt examination. The water is conceived to be kept ſuſpended in the tube by the attraction of the ſmall ring of glaſs immediately *above* the interior ſurface. But I aſk, Ought not the ring *below* to exert an equal force in a contrary direction, and conſequently deſtroy the effect of the former? This argument it ſeems impoſſible to elude, and to expand it would be ſuperfluous. We muſt therefore regard the common account of capillary action as entirely without foundation.

It may well furniſh matter for ſurpriſe and mortification to remark ſuch a glaring overſight committed in the very porch of the phyſical ſciences. But if we extend our obſervations we ſhall ſoon be convinced that the popular branches of philoſophy, with all their ſuppoſed improvement, are in general ſtill very defective and erroneous. Thoſe flowery departments have been left to the culture of a ſecondary order of men, whoſe imagination was commonly more powerful than their judgment. In every age the vigour of genius has been directed to the ſublimer parts, and thoſe united efforts have reared a ſtupendous monument of the penetration and reſources of the human mind.

In attempting to explain the mode of capillary action, the chief difficulty ſeems to ariſe from the prejudice that a *vertical* attraction is neceſſary to account for the elevation of liquor in the tube: yet this is aſſuredly not the primary direction of the force; for, the action of glaſs being evidently confined within very narrow limits, that virtue muſt be diffuſed over the internal ſurface of the tube, and conſequently muſt exert itſelf *laterally*, or at right angles to the ſides. Nor is it difficult to conceive how a lateral action may cauſe an aſcent. We know that in fluids a force impreſſed in *one* direction is capable of propagating itſelf in *all* directions. The tendency of the liquor to approach the glaſs, muſt occaſion it

to ſpread over the internal cavity of the tube, and, conſequently, to mount upwards.

But let us view the ſubject a little more cloſely. Suppoſe I put a drop of water upon a horizontal plate of glaſs: it will quit its globular form, adhere to the glaſs, and ſpread out till it has covered the plate with a thin aqueous film. What then is the cauſe of this phænomenon? It is ſurely not the mere incumbent weight of the water; for that would not have been ſufficient even to ſurmount the mutual adheſion of the particles of the fluid, or their natural tendency to agglobulate. Beſides, the ſame preciſe effect will take place if the drop be applied to the under ſide of the plate. The water therefore diffuſes itſelf on the glaſs in the ſame manner as if it were urged by the preſſure of a column acting againſt that ſurface. Its attraction to the glaſs is equivalent to this ſuppoſed preſſure, and is productive of the ſame conſequences. But why ſhould the mere tendency of the water to the ſurface of the glaſs occaſion a diſperſive motion? The reaſon is, that the external particles could not approach without ſpreading themſelves and extending the film: and analogy will inſtruct us, that the attraction of water to glaſs muſt increaſe in proportion to the proximity of its approach, till it has reached the term of cloſeſt union.

If the plate be held vertically the aqueous film will ſtill adhere, but only to a certain limited elevation, depending on its thickneſs. I reckon the force of ſuſpenſion correſponding to each inch of width, or of the extent of the horizontal linear boundary, as equal to the weight of about the 100th part of a cubic inch of water. Hence, if the film was only the 10000th part of an inch in thickneſs, it would maintain a height of ten inches; but if its thickneſs amounted to the 100th of an inch, it would ſubſide to an elevation of one inch.

Suppoſe I now dip the plate perpendicularly in a baſin of water, the film will ſuffer a very conſiderable modification. A new portion of water greedily attaches itſelf to the film, and depreſſes it by the load of additional weight. The curve of protuberance ſeems nearly an inverted parabola, and conſequently the preſſure to be ſuſtained is only the third part of what would obtain if the column had been of uniform thickneſs. The relative force of attraction is therefore $= \frac{1}{1000}$; and if we conceive the height to be equal to the breadth, which appears nearly the caſe, either of them will be denoted by $\sqrt{\frac{1}{1000}}$, or a little more than the ſixth part of an inch: a concluſion which correſponds ſufficiently with obſervation.

If

If two glaſs plates, held near each other and parallel, be dipped in water, the water will mount in the included ſpace. The aqueous protuberance is now confined, and the aſcent of the column is therefore greater; beſides that the effect is doubled by the united action of both oppoſite ſurfaces. Each ſurface acts only upon a thin film; but, ſince the force is ſpent in ſupporting the particles which adhere to this, the height of the column muſt evidently be inverſely as the weight ſuſpended, or the diſtance between the glaſs plates. Imagine the interval between thoſe plates to be the 100th part of an inch: then each ſurface may be conſidered as acting againſt a column of the thickneſs of the 200th part of an inch; and ſince the force of attraction is equivalent to the weight of the 100th part of a cubic inch, the correſponding aſcent muſt be two inches. In like manner, if the interval were only the 200th part of an inch, the height of the column muſt be four inches. In general, put d = the diſtance between the plates, and $\frac{1}{50d}$ = the height of the column.

The ſame reaſoning is applicable in the caſe of capillary tubes. The attraction of the internal ſurface is exerted on a thin circular lining; but this force is diluted and attenuated by the preſſure of the water which adheres to the film and occupies the cavity of the tube. A circle, it is well known, is equal to a rectangle which has the circumference for its baſe and half the radius for its altitude: conſequently the attractive power of the glaſs will produce the ſame effect as if it acted ſimply againſt a column whoſe thickneſs is one-fourth part of the bore of the tube. But we have already ſeen that the meaſure of force is expreſſed by $\frac{1}{100}$; and hence, if d denote the width of the bore, the height at which the water will be ſuſpended in the tube will be $= \frac{1}{100 \times \frac{1}{4}d} = \frac{1}{25d}$. Thus the altitude of ſuſpenſion in capillary tubes is the double of what obtains with parallel plates whoſe mutual diſtance is the diameter of the bore.

The ſuſpenſion of water in capillary tubes muſt depend entirely on the ſmallneſs of the ſuperior orifice. Nor will the effect be in any degree altered, however much the lower part of the tube be enlarged: for, by the laws of fluids, the preſſure is proportional merely to the altitude of the column; and this preſſure is balanced at the upper extremity by the adheſive force of the film, which attaches itſelf to the inſide of the tube.

If a capillary tube be inſerted through another tube, and both dipped in water, it will riſe not only in the capillary bore, but in the interſtice between the two tubes. Even though the diameter of the outer tube be conſiderable, the water muſt form a ſenſible elevation in the intermediate ring; and this elevation will be determined by comparing the extent of the oppoſite ſurfaces of glaſs with the intercluded ſpace on which their action is ſpent. The abſolute aſcent in the capillary bore continues the ſame; but, if we eſtimate it from the external protuberant ring of water, it will appear evidently diminiſhed. Conceive the outer tube to be fitted with a bottom, and the whole to be removed from the baſin: the effect will ſtill remain the ſame, and conſequently the apparent altitude of the fluid in the capillary bore will be diminiſhed. Let d denote this bore, d'' the diameter of the tube, and d''' the width of the outer tube, or rather that of the ciſtern in which the capillary is plunged: then it may be eaſily inveſtigated, from the principles already explained, that the height to which the water will riſe is $= \frac{1}{25}\left(\frac{1}{d} - \frac{1}{d''' - d}\right)$ in inches.

If the tube has its lower orifice not too wide, on removing it from the ciſtern in which it was immerſed, a drop of water will adhere, and the column in the capillary bore will remain at the ſame height. Its ſuſpenſion, we have ſeen, is produced by the lateral adheſion of the internal film, to which a cylinder of water attaches itſelf. If the drop at the extremity be diminiſhed by any cauſe, ſuch as the contact of bibulous paper, the column will ſubſide; for the tendency of the water to agglobulate then counteracts, in ſome degree, its capillary extenſion in the tube. Cover a horizontal piece of glaſs with a fine film of water, and bring the tube with its charge to touch it, the water will immediately deſert the cylindrical cavity and ſpread over the film. The attraction which the vertical column of water, joined to its weight, bears to the expanſive horizontal film, overcomes its adheſion to the narrow film that lines the inſide of the tube. We here contemplate the extreme caſe; but it ſhould be remarked in general that the mutual attraction of the particles of water or other fluids muſt, to a certain degree, diminiſh their aſcent in capillary tubes, ſince that force tends to agglomerate the parts, and conſequently oppoſes any ramifications or filamentous prolongations of the fluid. This reſiſtance, it might

be ſhown, is, like the capillary action itſelf, inverſely as the width of the bore. The two oppoſite effects, being thus proportional, are confounded, and their difference only is obſerved. In the caſe of glaſs, the capillary action greatly preponderates: one conſequence of this is the concavity remarked at the top of the column; a clear proof that the lateral exceeds the central adheſion. If the upper ſurface were perfectly flat, thoſe two forces would be in exact equilibrium. But the convexity of the top of the column proves that the fluid has a greater attraction to its own particles than to glaſs. Such is the caſe with quickſilver, which, inſtead of aſcending in capillary tubes, ſuffers a depreſſion according to the ſame law. This remarkable fact has been aſcribed to ſome repulſion exiſting between quickſilver and glaſs. But I regard ſuch a ſuppoſition as equally unneceſſary and improbable. The ſame conſequence would, no doubt, take place with water in poliſhed tubes of ſteel or braſs. If I place a drop of water on a ſmooth ſurface of metal, or a globule of quickſilver on a plate of glaſs, neither of them will ſeem at all affected by the contact, but will obey the attraction of their own particles, and therefore affect the ſpherical form.

Hence the mercury in a barometer can never mount to its true height; and the error will be the more conſiderable in proportion as the tube is narrow. If two tubes of different diameters be carefully filled and planted in the ſame baſin, the mercurial column will ſtand viſibly higher in the wider tube. This aberration has been generally neglected, though it muſt evidently affect the barometric calculation of the altitudes of mountains *.

On the ſame principle I would explain the familiar experiment of a needle ſwimming on the ſurface of water. It is ſuperfluous to have recourſe to any ſuppoſed repulſion. The internal coheſion of the water oppoſes its diviſion; a gentle cavity is formed, which, preſſing upwards, ſupports the needle.

Above twenty years ago, that able chemiſt M. Guyton-Morveau, examining into the nature of chemical affinities, attempted to determine the relative attraction of a variety of ſubſtances, from the force required to detach ſmall plates of glaſs or metal from their contact with water or quickſilver. The

* Suppoſe the mercurial column at the bottom of the mountain to be 30 inches, at the ſummit 15; and let the depreſſion be equal to the 20th of an inch, which correſponds to ordinary tubes. Then the corrected columns are 30·05 and 15·05; but the ratio of theſe numbers is different from that of 30 to 15, and conſequently it will give a different altitude. The common calculation will repreſent the mountain above 90 feet higher than it ought to be.

idea, though not logically accurate, was ingenious, and had a certain degree of ſucceſs. It is evident that the force meaſured was not ſtrictly that of mutual attraction, but only the weight of the protuberant maſs of fluid the moment before its ſeparation. Nor does the height of this column depend on its mere adheſion; for it can never exceed the coheſive force of the fluid molecules to each other. When the plate, whatever may be its attractive power, is raiſed above a certain limit, the attached column breaks, and part of it adheres to the plate, while the reſt falls back into the body of the fluid. Thus, thoſe experiments can aſcertain the adheſion of the plate only when it is comparatively very ſmall; in other caſes they meaſure ſimply the integrant attraction of the particles of the fluid. If capillary action be regarded as approximate to chemical affinity, this may be always determined, with facility and with ſufficient accuracy, by obſerving the aſcent in two parallel plates fixed at ſome minute but known diſtance from each other.

The elevation of a liquid in a capillary bore is produced by its ſpecific attraction to the matter of the tube. With different ſubſtances the effects are conſiderably diverſified: alcohol, for example, riſes little more than a third part of the height to which water reaches. But the ſlighteſt alteration in the conſtitution of the ſubſtance will ſometimes occaſion a very material difference of effect. Thus I find that, on diluting the alcohol, the aſcent of the liquor is ſcarcely at all augmented; but, if I reverſe the proceſs, and add a few drops of alcohol to the water, the capillary column will ſuffer a remarkable depreſſion. On this principle might be conſtructed a very ſimple hydrometer for meaſuring the ſtrength of weak liquors. And I would invite chemiſts to try capillary action with different ſaline and metallic ſolutions, as I am confident that many curious facts would thus be diſcovered. Nothing could exceed the ſimplicity of ſuch an inſtrument. It is only neceſſary to chooſe a fine calibred tube, and to have it divided on the outſide into equal parts by the point of a diamond, or marked with enamel colours. On plunging it into the liquid and then removing it, the preciſe effect would be indicated by the ſuſpended column. I have no doubt but that ſuch an inſtrument, in the hands of a ſkilful operator, would be brought to mark, with ſufficient exactneſs, the proportion of ingredients contained in a compound fluid, and might in ſome caſes ſuperſede the trouble of analyſis itſelf.

The aſcent of water through pounded glaſs, ſand, and other powdery ſubſtances, is juſtly explained by capillary action.

action. The effect is produced by the attraction of the numerous proximate facets; and it is the more notable, as the aggregate furface is very large in comparifon with the interftices to be filled up with humidity. But the abforption of water by bibulous paper, linen, or flannel, though commonly referred to the fame caufe, is of a very different nature. From clofe obfervation I am convinced that in thofe inftances there occurs a real though not a permanent change of conftitution: the folid begins to affimilate itfelf to the qualities of the combined fluid, and becomes fofter and more tranflucid. By means of an inftrument, contrived to meafure the fmalleft alteration of volume, I have proved decifively that the union of water or oil with paper or linen is accompanied with a general contraction or concentration of the mafs. Nay, applying a delicate thermometer, I perceived a very fenfible extrication of heat invariably to take place during fuch combinations. And this effect was the greater in proportion to the previous dryneſs of the folid. Thus I have fometimes produced a heat of ten degrees by moiftening faw-duft which had been parched before the fire. An abforption of this kind is ftrictly a chemical procefs: the internal ftructure of the folid is altered, and a force is developed very diftinct in quality and degree from what obtains in capillary action. The contemplation of fuch facts may ſerve to extend our ideas of chemical agency. The ftate of fluidity is eſſential to its operation; but that quality is required only in one of the ingredients, and the refult of the combination may be indifferently a fluid or a folid. Copper will imbibe quickfilver and become only more brittle; and, on the other hand, quickfilver will diffolve a fmall portion of copper without relinquifhing its fluid character. Nay, if the one fpecies of combination can be produced, we may fafely infer the exiftence of the other. Thus all ftones are found to contain water incorporated in their fubftance, altogether diftinct from what may infinuate itfelf in their accidental crevices. If we reverfe the combination, therefore, and fuppofe the fluid to predominate, we fhall conclude that water is to a certain degree capable of diffolving all forts of ftones. And if, difregarding the authority of difputed fyftems, we candidly examine the numerous facts that occur in geology, we cannot hefitate to admit the juftneſs of the propofition. I would not venture, however, to maintain that water is fingly capable of diffolving the hardeft ftone; for the cohefion of the integrant molecules will, in fome cafes, oppofe a force fuperior to the attraction of the water. But the procefs may

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be aſſiſted by the concurrence of other agents that tend to diſunite the ſolid. In general, the action of chemical affinities admits of compariſon with the application of mechanical force. There are ſome obvious facts which at once illuſtrate and confirm this principle. For example, carbonic gas, combined with water, enters into the compoſition of marble; but neither of thoſe fugitive ſubſtances, however concealed or diſguiſed, yet abandons its ſpecific character. On the application of intenſe heat their elaſticity becomes developed with irreſiſtible force, and they make their eſcape, leaving the ſtony baſis in the dry cauſtic ſtate of quicklime. I ſhall mention one other fact which exhibits the play of chemical affinities. Charcoal, it is well known, has the property of imbibing air; and I have proved from experiment that this impriſoned air exiſts in a compreſſed or condenſed ſtate. But water, being applied to the charcoal, will be immediately abſorbed by ſuperior attraction, and will diſlodge the air, which now recovers its uſual expanſion.

Sulphuric acid, potaſh, and in general all the deliqueſcent ſalts, have the power of attracting moiſture from the atmoſphere. They exert a real chemical action which overcomes the adheſion of humidity to the air. But I have remarked the ſame property to obtain more or leſs in a great variety of ſubſtances; in paper, linen, flannel, wood; nay, in ſtones and earths. The water, thus abſtracted from the atmoſphere, penetrates into their ſubſtance and diſappears. The ſurface of glaſs ſhows, in a limited degree, a ſimilar power. I have obſerved that, on the approach of evening, bits of glaſs became covered over with minute globules long before the ſurrounding air was abſolutely damp. About the temperature of freezing I have noticed this dew to appear on the ſurface of the glaſs, when my hygrometer ſtill indicated a dryneſs of five degrees. But in higher temperatures the effect was even more ſtriking; and I have ſeen the ſides of a tumbler covered with dew when the ambient air poſſeſſed 15 degrees of dryneſs. In thoſe caſes, however, the humidity is merely detached from the air by the action of the glaſs, and it remains adhering to the ſurface without being abſorbed into the vitreous maſs. The effect cannot, with any appearance of probability, be imputed to a ſuppoſed alkaline efflorescence; for it was obſerved with fine flint glaſs, and the dew collected was always perfectly taſteleſs. When poliſhed metals were expoſed, they never received any dew till the atmoſphere was abſolutely damp. They ſeem therefore to be entirely paſſive.

This ſingular property of glaſs is certainly a modification of

of capillary action: it must therefore obtain in other kindred substances. I am inclined to refer it to the same cause, however apparently subtle, which has so forcibly struck me in some other researches. It is well understood that physical is different from mathematical, contact. In the former there is a finite interval whose extent is various, depending on the mutual relation of the bounding surfaces. The degree of approach is greater in some cases than in others, or the contact is of a more perfect kind. I have proved lately, I think to demonstration, that air is separated from the polished surface of metal by a much wider interval than from glass or other substances. The air therefore, charged with its humidity, approaches so close to the glass, that the latter exerts most powerfully its specific attraction, and detaches the minute globules of water. Paper and other vegetable substances, though saturated with moisture, and therefore capable only of displaying capillary action, seem to possess the same property as glass.

I consider the power of abstracting humidity from the atmosphere as of important consequence in the vegetable economy. Plants may thus inhale liquid nutriment, when the ambient air is still far from being disposed to part with its watery store. And we have seen that heat promotes the effect. Hence certain vegetable tribes, without feeling the beneficial influence of rain or dews, are yet capable of existing in the sultry arid plains of Arabia. They extract a scanty supply of moisture from the air by a sort of chemical process. Perhaps the organic structure of the plant may conspire with its physical quality in augmenting the effect.

The celerity of the flow of liquids in capillary syphons depends chiefly on a circumstance which, I believe, has not hitherto been noticed. If we consider with a little degree of attention the motion of water through a narrow passage, we shall soon be convinced that it is not regular and uniform. The obstruction at first experienced occasions a certain accumulation, which at length overpowers resistance and causes a partial acceleration. In this manner, a sort of continual reciprocating tide is produced in a series of pulses more or less intricate. This curious effect is distinctly visible in artificial *jets-d'eau*. But the same thing may be perceived in every current of water. Hence the varying dimpled surface and the gentle murmur, of brooks. The volume of water continues the same; but its contours and flexures are incessantly changing, and soothe the fancy by exhibiting a picture of animation. After performing a certain cycle, however, the same irregularities are again repeated; and hence the musical cadence

dence of rivulets, ſo cloſely aſſociated in our minds with luxurious eaſe and the calm pleaſures of paſtoral life.

If we examine carefully the aſcent of mercury in a fine thermometer, we ſhall find that it mounts by a ſucceſſion of ſtarts. It ſeems to force itſelf along by a ſort of vermicular motion. Nor does the reſiſtance depend much on the friction experienced againſt the ſides of the tube; it is owing chiefly to the waſte of force in impreſſing a narrow thread of liquid with thoſe concatenated contractions and dilatations indiſpenſable to progreſſive motion. I muſt obſerve that the term *fluidity* itſelf is merely of relative import. A ſolid body may ſoften by inſenſible gradations, and paſs into the ſtate of a fluid. In this new condition the particles are indifferent to poſition, and therefore eaſily admit of inteſtine motion. But ſuch a property implies an extenſion of the ſphere of mutual connection. In a large ſyſtem of molecules, the ſlighteſt alteration in the ſituation of each is ſufficient to produce a total change of arrangement. It is otherwiſe when the group is very limited. The compoſition of a fluid may thus be conceived to reſemble a long ſpring, which bends eaſily and without riſk under the ſmalleſt preſſure; while the ſtructure of a ſolid may be compared to a ſhort ſpring, which yields only to the application of a great force, and is then liable to break. But the action of heat extends this imaginary ſpring, and promotes ſoftneſs and fluidity. Thus a bit of ſealing-wax, held near the flame of a candle, gradually loſes its angles and protuberances; an evident proof that the ſphere of mutual coheſion is enlarged. And every perſon muſt have remarked that oil, during the heat of ſummer, becomes apparently thin, and flows with facility. Nay, water itſelf undergoes a ſimilar change of conſtitution, though it eludes ordinary obſervation. I bend a thermometer tube, with rather a wide bore, into a ſiphon, which I inſert into a tumbler of cold water, and count how many drops fall in a minute. I then empty the tumbler, and fill it to the ſame height with hot water; and, replacing the ſiphon, I find that the drops, which are ſtill of the ſame ſize, ſucceed each other much more rapidly than before, inſomuch as ſometimes to form a continual ſtreamlet. I conclude, from ſeveral trials, that the velocity of the flow is at leaſt ſix times greater near the boiling point than on the verge of congelation. But the difference may be rendered much more ſtriking in another way. The height to which liquids are projected is proportional to the ſquare of their initial velocity. Provide, therefore, a glaſs tube three or four feet long and more than half an inch wide: by the help of a blow-pipe, draw

out the end into a tapering capillary bore, and, a little above this, bend the ſhoulder back parallel to the tube. Then, holding the tube perpendicular, fill it with cold water, and break off by degrees the ſlender ſtem till the water begins to ſpirt up perhaps half an inch. Now plunge the lower end of the tube, for the ſpace of a minute or two, in boiling water, and, on removing it, the jet will appear to dart almoſt to the height of three feet, but will gradually ſubſide as the heated portion of water is expended.

The ſame experiment will ſucceed, though in different proportions, with alcohol and even mercury. Yet all theſe are commonly deemed perfect fluids; nor can we doubt that the application of heat will in every caſe increaſe the tenuity of the liquid ſubſtance, and heighten its degree of fluidity. If water thus experiences ſuch a change, the effect muſt be proportionally greater on the dilute ſolution of mucilaginous and ſaccharine matter which conſtitutes the ſap of plants. The return of ſpring, by the mere phyſical influence of its warmth, will promote the flow of the juices deſtined for the nouriſhment of the vegetable tribes. That genial ſeaſon, therefore, not only reanimates the principle of life, and ſtimulates the organs of ſecretion to elaborate their fluids, but quickens the circulation of thoſe fluids through the fine ramifications of the ſap-veſſels. Hence the rapid growth of plants in the hot climates. Hence, likewiſe, the quick vegetation remarked within the polar circle, where, for the ſpace of weeks or months, the ſlanting rays of the ſun play without intermiſſion.

Verſailles,
October 9, 1802.*

* This paper was drawn up in great haſte for a particular occaſion. It is now printed without alteration, although the author is conſcious of its defects in point of unity and arrangement.

XXXI. *Observations on the Salt of Bitumen; the Bit-Noben of the Hindoos.* By JOHN HENDERSON, *Esq. Surgeon on the Bengal Establishment* *.

Sal Indus vel subniger, vel subrufus, obscurus omnibus fortior.
Messue, c. xvi.

Et alius est Indus, qui est niger, non nigredine napticitatis.
Avicenna, lib. ii. c. 624.

THE saline substance which has lately been imported into Britain under the name of *salt of bitumen*, is not, as might be inferred from the title, a natural production, but an artificial preparation of great antiquity invented by the Hindûs. It is known in India by various appellations †; but the trivial name, by which it is familiar to those who have resided any time in that country, is *khala nimuc*, or black salt. It is met with in every village in large irregular lumps, for the most part of a dark brown colour.

It has a strong saline taste, with a peculiar sensation diffused over the mouth, which is not easily described. At first, the taste is disagreeable: but I have been told by those who were in the habit of using it, that it not only becomes pleasant, but is often taken to remove a disagreeable taste in the mouth. When the salt is perfectly dry, it has scarcely any perceptible smell, but when moistened it sends forth a strong sulphureous fœtor.

It dissolves readily in a small portion of water, forming a solution of a greenish colour, which emits a strong sulphureous smell, resembling bilge water, or the foulest gun-scourings. By exposure to the air, the smell gradually abates, and the greenish tint disappears, the liquor becoming as clear as the purest water: when this has taken place, if the solu-

* Communicated by the Author.—This presents a curious specimen of the Hindoo physic; and further, it may suggest to British practitioners the trial of hydro-sulphurets alone or in combustion, as in the case of the present salt, in many untried diseases.

† By the Hindoos it is called *bit-neben*, *padnoon*, and *sooncherloon*; in Arabic and Persian MSS. *melk*, *melk-nusk*, *melk-i-swed*, *nimuci-nusk*, *nimuciled*, and *nimuci-hindi*. It is the *sal-naphtheus Indus vel Indicus* of the Latin versions of the Arabian and Persian authors; the *pharma opeia augustana* of the earlier editions of the *Pharmacopeia Londinensis*, &c. It must be observed, that all the formulæ of which it is an ingredient in the different pharmacopeias, are copied from the Arabian authors; and therefore I doubt much whether it was ever imported into this country before, or even into Europe in any considerable quantity, for I find no particular account of it in any of these books. It is, perhaps, the *sal-asphaltites* and *spumenus* of Pliny and Galen.

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tion has been pretty ſtrong, on pouring out the water, the inſide of the veſſel in which it was contained is found lined with a cruſt of a dark brown colour; a phænomenon obſerved in moſt ſulphur wells: this will be beſt diſcovered if the experiment is made in a glaſs veſſel.

A ſilver ſpoon laid over a freſh ſolution of the ſalt became diſcoloured in the courſe of a few hours; and a little ſugar of lead put upon the ſhank of the ſpoon, and kept over the ſolution during the night, was found in the morning conſiderably blackened. A few drops of the nitric acid added to the freſh ſolution cauſed a milky appearance, and a little acetate of lead poured into a glaſs of it cauſed a precipitate that filled nearly one-third of the glaſs. The hepatic gas is in ſuch abundance, that, by expoſing a ſtrong ſolution in a tumbler to the air, the ſulphur becomes at once evident, in the cruſt with which the glaſs is uniformly found to be lined.

After a ſolution of the ſalt had been expoſed to the air till it became perfectly clear, a quantity of it was poured into a china plate, and gradually evaporated by the heat of the ſun: there remained in the plate a number of cubical cryſtals, evidently pure common ſalt, without any other reſiduum. The ſalt, from the taſte, and ſome curious phænomena attending it, appeared to be of an uncommon degree of purity.

From theſe experiments it appears that ſalt of bitumen is chiefly compoſed of common ſalt and hepatic air, or, in the language of modern chemiſtry, of muriate of ſoda and ſulphureous hydrogen gas, the two principal ingredients that impregnate the mineral waters of Aix la Chapelle, Baden, Harrowgate, Moffat, and moſt of the celebrated ſulphureous ſprings in Europe.

There are very few ſulphurated ſprings, either hot or cold, in Hindooſtan: I only heard of one, "in the province of Burdwan," in all the country from Hurdwar to Point Palmiras. How far the Hindoos have ſucceeded in diſcovering the deſideratum for preparing them artificially appears from the above analyſis, and will be confirmed by comparing a ſolution of the ſalt with the ſulphurated waters at their ſources. All the European proceſſes and machinery for imitating theſe waters have been directed to the impregnation of water with gas diſengaged from *hepar ſulphuris*, which produces an imitation of the ſulphurated waters mentioned by Dr. Coggan in his Travels on the Rhine, but not of Moffat or Harrowgate: it may perhaps be found that air diſengaged from common ſalt is different from that of *hepar ſulphuris*, and in ſulphur ſprings the ſalt ſeems to be a very univerſal ingredient. Not only the waters already mentioned, but theſe of Corſtorphine,

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St. Bernard's Well, Broughton, Deddington, Crickle Spa, Durham, Rippon, Shipton, Keddleſtone, Sutton Bog, &c. &c., have all common ſalt for their baſis. This diſcovery of the Hindoos is upwards of two thouſand years old, and far ſurpaſſes all the attempts of modern chemiſts to make artificial ſulphurated waters *: they have perhaps diſcovered the very proceſs employed by nature in the formation of them.

The Arabians and Perſians, and even the Muſſulmans in India, have generally conſidered ſalt of bitumen a natural production; and thoſe who allow that it is made in the country inſiſt upon two kinds, the one natural and the other artificial, and that the latter is only an imitation of the natural. The Mahummedans have ſuch a contemptible opinion of the Hindoos, that they are much more diſpoſed to believe it dug out of the earth, or formed from the water of the Mare Mortuum, than that it is a production of Hindoo chemiſtry. Some of the chemiſts to whom I ſhowed it in this country were alſo inclined to conſider it as a natural production. That it is an artificial preparation I am perfectly convinced, from the information of the natives, from having ſeen a maſs of the ſalt in the form of the earthen veſſel in which it had been made, and from having ſucceeded, in a great meaſure, in making it: finally, Mr. Robertſon, the gentleman who collected and ſent it from India, writes, that the ſalt is manufactured in the neighbourhood of the city of Agra, where it may be had in any quantity. Although I was at conſiderable expenſe with the native chemiſts and alchemiſts, yet I muſt confeſs that I never prepared any ſalt equal to what was to be got in the bazar or market-place. I ſhall therefore not deſcribe the different proceſſes performed by my operators. I ſhall only remark one part, in which they all agreed, and that was, the igneous fuſion of common ſalt with a very celebrated Hindoo medicine called *turp'hulla* †, or the three fruits, a name given by way of

* Even in the gaſeous part, the preſent artificial ſulphurated waters are ſaid to be different. In the report made to the National Inſtitute of France by citizens Fourcroy, Chaptal, &c. reſpecting the artificial mineral waters of Meſſrs. Paul and Co., they obſerve, 9thly, finally, "the ſulphurated appeared to the committee not ſufficiently impregnated with ſulphurated hydrogen gas."

† *Turp'hulla* is the *atriful* of the Arabians and Perſians, and the true and genuine origin of thoſe celebrated compoſitions, long retained in the pharmacopeias of Europe under the title of *tryphera*; a word which ſeems to have exhauſted the ingenuity of our lexicographers, who, I find, are faſt expelling it from their lexicons and dictionaries. It never had any connection with the Greek word τρυφη, nor the *typhera* of Scribonius Largus.

diſtinction

distinction to the Chebul, Belleric and Emblic myrabolans. I must here observe, that there is not a particle of sulphur, alkali, or calcareous earth, used in the process. I have often tried solutions of the salt with infusions of flowers, that afforded very delicate tests of the presence of acids and alkalies, but never discovered the smallest appearance of either.

As a medicine for man and beast, salt of bitumen is more extensively used in Hindoostan than any article of the materia medica that I know of; and, except common culinary salt, I know no medicine the consumption of which comes near it. It forms the basis of those compositions called *massalas*, which the natives in charge of horses, elephants, camels, and other cattle, are in the habit of demanding, once a month, or oftener, as essentially necessary to keep them in proper condition. The Hindoos themselves also use great quantities of it, and have frequent recourse to it to improve their appetite and digestion. They consider it a specific for obstructions of the liver and spleen, particularly for that affection of the spleen called in England the *ague cake* *; which is a very frequent disease in India, and well known there by the trivial names *peely* and *bose*. It is a most obstinate disorder, often continuing for years, and resisting the most powerful remedies: after every other has failed, it has been frequently known to give way to a course of the *bit-noben*.

It is in high estimation as a remedy in paralytic disorders, particularly for that species of palsy where the organs of speech are affected. It is much used for different cutaneous affections, worms, old rheumatisms, indigestion, want of appetite; in short, it is considered the grand restorative for man and beast in all chronic disorders. Great quantities of the salt are used by the *salûtras*, or native farriers, who seem perfectly to understand the principle on which its efficacy depends; for, after giving a horse a dose of the salt, which is done by mixing it with his food, they always give him water to extricate the gas.

* This affection is, I believe, a rare disease in England, and seldom treated of in medical books. In the East, it is not only often brought on by long-continued fevers, but is a frequent primary disease, and under the titles *wurm el tebal* and *amasi jeturz* is particularly described in almost every Persian and Arabic MS. on the practice of physic.

There is a remedy for the enlargement of the spleen, now very popular in Bengal, called *Lynd's pill for the bose*, which, from the heterogeneous ingredients of which it is composed, has generally been considered by the practitioners there as an useless farrago: however, its efficacy has been such as to bring it into high repute. It was in analysing this pill that I became acquainted with the virtues of salt of bitumen.

Mr. Lynd was a head surgeon of eminence on the Bengal establishment.

XXXII. *Memoir on the Refining of Lead; with some Reflections on the Inconvenience of Ash Cupells; and the Description of a new and economical Method of constructing Cupells or Refining Vessels: read in the French National Institute. By* C. Duhamel, *Member of the Institute and Inspector of Mines*.*

It is well known, that to separate silver from lead, a metallurgic process called refining or cupellation, performed in a vessel called a cupell, has been employed: it is known also that this vessel is composed either of the ashes of the bones of animals, or of those of vegetables, after they have been lixiviated, to free them from the saline matters which they may contain.

The great quantity of wood-ashes which must be employed in the construction of cupells, and the difficulty of obtaining them, long ago induced me to endeavour to discover a simpler and less expensive method of constructing the vessels in question. The old chemists having observed that lead becomes oxidated, or reduced into what is called *litharge*, when exposed to heat, or the contact of the atmospheric air, while the silver united to it retains its metallic form, nothing seemed necessary but to find the means of separating these two metals. They were conducted to the method of accomplishing this by observing that the oxide of lead, in its state of liquefaction, easily penetrates the substances which are in contact with it, and especially bone-ashes, without deforming the vessels which are formed of them. No matter, indeed, is more proper than the latter for constructing small refining cupells.

The difficulty, and often even the impossibility, of obtaining about 160 English gallons of ashes for each operation of refining on a large scale in the German furnaces, made the proprietors have recourse to wood-ashes: but, besides that these ashes are expensive, it often happens that they cannot be procured in sufficient quantity. They are even attended with one inconvenience, which is, that they come off, and float on the fused lead; the refining then fails: and this takes place every time that the ashes are badly prepared, that the cupell is insufficiently or not uniformly beat, or when the canals destined for the evaporation of the moisture are neither in sufficient number, nor properly arranged, nor covered with a stratum of scoriæ, on which is established the bottom, that receives the ashes, and which ought to be con-

* From the *Journal des Mines*, No. 64.

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ſtructed of the moſt porous bricks, in order that the water, with which it is neceſſary to moiſten the aſhes, may penetrate them in evaporating, may proceed to the bed of ſcoriæ, and eſcape by the ſpiracles which are at the baſe of the furnace.

To aſcertain the proportion of lead in ſilver, it is ſufficient to put ſome pennyweights into a ſmall cupell of bone-aſhes placed under the muffle of an aſſaying furnace. In proportion as the lead becomes oxidated, it inſinuates itſelf into the cupell, and the ſilver at laſt aſſumes that vivid appearance which announces that the whole lead is diſſipated, that the ſilver it contained is refined, and has attained to its *maximum* of purity.

In refining on a large ſcale, the object alſo is to ſeparate the ſilver from the lead, but not to make the whole of the latter penetrate into the cupell, which is even impoſſible; for in that caſe it would be neceſſary to have a much larger quantity of aſhes for the total abſorption of the metal: beſides, the operation would require a period ten times as long as that uſed in general for refining, and would occaſion ten times the expenſe in fuel, and a much greater loſs of the metals than by the uſual proceſs, where the greater part of the lead is obtained in litharge, while a portion penetrates into the cupell for about two inches of its thickneſs, which muſt be fuſed to revive the lead. This reduction is alſo more expenſive, and experiences a greater loſs than the litharge, which is eaſily fuſed, and which, without paſſing through the furnace, may be employed as an article in commerce.

Lead ore and litharge may be fuſed as in England, and the department of the ci-devant Brittany, in a reverberating furnace the ſoles or baſons of which are formed of pounded and moiſtened clay. Theſe ſoles can ſtand the action of heat and of the oxide of lead for ſix or eight months of uninterrupted labour.

The durability of theſe earthen ſoles gave me the firſt idea of the method, which I ſhall hereafter propoſe, for refining-furnaces, where the only thing required is to oxidate the lead to obtain it in litharge, and not to cauſe the cupells to imbibe the whole of it, as is done when the object is to aſſay the metal in order to know whether it contains ſilver. In operating on a large ſcale, the cupell, though of aſhes, abſorbs only a part of the lead, as I have already ſaid, obſerving at the ſame time that it would be much more advantageous to obtain the whole transformed into litharge, the reduction of which into lead is much eaſier than that of the

oxide contained in the aſhes, which oppoſe fuſion, and the ſcoriæ of which always carry with them ſome of the metal.

In a cupell of aſhes beat into an oval circle of iron, the greater diameter of which is only five or ſix feet and the leſs one yard, the Engliſh refine from a ton to 23 cwt. of lead, which is converted into beautiful litharge, except the ſmall portion which penetrates into the cupell, the thickneſs of which is only about $2\frac{1}{2}$ inches, and which is ſupported under the arch of the furnace by two bars of iron. A pair of leather bellows drive the litharge towards the anterior part of the furnace, from which it falls, without interruption, on the floor of the foundry, while, to fill up the vacuity left by the oxide running off, an ingot of lead placed cloſe to the baſe of the bellows is made to advance gradually into the interior part of the furnace. This lead, by fuſing, keeps the cupell full till towards the end of the operation.

If I have here given a ſhort view of the proceſs of the Engliſh, it is only to ſhow that it is poſſible to perform operations of refining by employing only a ſmall quantity of aſhes for the conſtruction of cupells. Thoſe in queſtion do not abſorb 90 pounds of oxide in the large quantity of lead which is refined.

It is then proved that metallurgiſts have always endeavoured to obtain the greateſt quantity poſſible of litharge, and little aſhes impregnated with oxide; but as they thought that they ought not to deviate from the docimaſtic proceſs, they have always conſtructed their cupells of aſhes.

It has been ſeen that in cupellation on a ſmall ſcale, lead, in proportion to its oxidation, penetrates the aſhes. When no more is left, the ſmall button of ſilver remains pure at the bottom of the baſon under a ſpherical form. This operation takes place with the more celerity, as the ſurface of the maſs is always convex in theſe ſmall veſſels; which allows the oxide to flow as on an inclined plane, towards the edges of the cupell, where it is immediately imbibed.

The caſe is not the ſame with cupells on a large ſcale, which are ſeveral yards in diameter: bellows muſt be applied, the wind of which ſerves not only for accelerating the oxidation, but alſo for driving the litharge towards the gutter formed for its eſcape.

We have remarked the inconveniences and even the impoſſibility of making the whole lead penetrate into the aſhes of large cupells: oxidation, indeed, is not effected but in the parts of the maſs expoſed to the contact of the air or to the wind of the bellows; but as litharge, towards the middle of the baſon, could not reach its edges, it would remain there.

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in a ſtate of ſtagnation, and would neceſſarily oppoſe the formation of a new ſtratum of oxide. This has induced metallurgiſts to expel the litharge by the wind of a pair of bellows in proportion as it is formed, and to make it flow from the furnace.

Oxidation then takes place only at the ſurface of the maſs, and not at its lower part: if the caſe were otherwiſe, the aſhes of cupells would be penetrated by the oxide to a thickneſs the more unequal, as the operation is longer; but I have always remarked, that the *teſt*, or the part of the aſhes impregnated with litharge, in refining on a large ſcale, is not thicker in the centre of the baſon than towards its circumference, though the lead remains thirty or forty times as long in the bottom as on the edges; ſince the maſs continually decreaſes till the whole lead is reduced to litharge, and till nothing remains but a cake of ſilver at the bottom of the cupell.

If the whole lead is imbibed by the aſſaying cupell, it is becauſe this ſmall veſſel is expoſed to a heat uniform in all its parts. As the cupell, in operations on a large ſcale, preſents to the action of the caloric only its upper ſurface, the oxide imbibed ceaſes to penetrate it at the place where the temperature is no longer high enough to keep that oxide in a ſtate of fuſion. For this reaſon, the thickneſs impregnated is equal throughout the whole extent of the cupell; and this prevents the poſſibility of making the whole lead penetrate into the aſhes.

From the above obſervations it may eaſily be conceived, that if the aſſaying of lead ought to be performed in ſmall cupells of bone-aſhes, in order that the oxidated metal may penetrate them, and be in part evaporated, the caſe is different with refining on a large ſcale, where it is neceſſary to accelerate the operation, and to obtain as much litharge as poſſible.

I have already ſaid, that the wood-aſhes of which cupells are made for refining on a large ſcale are expenſive; that very often a ſufficient quantity cannot be procured; and that beſides this, part of the aſhes, and ſometimes the whole, ſeparate themſelves entirely from the ſole; which occaſion a conſiderable loſs. I ſhall add, that to give more weight and conſiſtence to the cupells, it is often neceſſary to mix with the aſhes a large quantity of ſand; eſpecially if the lead contains foreign ſubſtances, ſuch as arſenic, cobalt, antimony, tin, &c. If the lead be only arſenical, after having ſeparated the firſt ſcum, a quarter of a hundred weight of iron filings or caſt iron turnings are now and then thrown over the whole

ſurface of the maſs. This iron, being lighter than lead, floats over it and abſorbs the arſenic, after which the maſs muſt be ſcummed: ſoon after, the litharge is formed without any obſtacle. This method is employed in Saxony.

The neceſſity of adding ſand to the aſhes of cupells muſt have conducted to the diſcovery of the following means, which I ſhall here propoſe.

New Method of conſtructing Baſons for Refining.

Without making any change in the maſon-work of the refining furnace, called the German, care only muſt be taken to form at the bottom a ſufficient number of canals for the evaporation of the moiſture, and to arrange them in the manner beſt calculated to produce that effect. Theſe canals or ſpiracles muſt be covered with a bed of ſcoriæ, over which a pavement is to be made of one layer of the moſt porous bricks.

On this area, which muſt be concave like the ſole on which the aſhes of common cupells are beat, place founders' ſand a little moiſtened; to which may be added a fifteenth part of argil, if it is not ſufficiently earthy, in order to give it the requiſite ſolidity; and the whole muſt be carefully mixed. This ſand muſt be rammed in the ſame manner as for conſolidating aſhes; and a refining baſon is to be formed in like manner, uniformly beat in all its parts. The thickneſs of this cupell muſt be ſix or ſeven inches: it may be formed of two ſtrata, as will be ſeen hereafter.

After the baſon has been uniformly beat in every part, about a gallon of lixiviated wood-aſhes may be ſifted over its whole ſurface, and rendered adherent with beaters.

When the cupell is thus prepared, let down the head on the furnace and make a moderate fire in the fire-hole; which muſt be maintained for ſeveral hours, in order to cauſe a part of the water, with which the ſand has been moiſtened, to evaporate. The ſurplus will be diſſipated during the operation, without any inconvenience, by canals of evaporation.

After a ſufficient deſiccation, raiſe the head and ſuffer the cupell to cool a little; ſpread out ſtraw or hay over it, and arrange the ingots of lead, placing them gently on it that their weight may not derange the ſand: it is to prevent ſuch derangement that ſtraw is employed, as is done in regard to cupells of bone-aſhes *. When the quantity of lead neceſſary for filling the cupell is arranged in the furnace, let down

* Inſtead of priſmatic ingots it will be better to caſt the lead in hemiſpherical iron moulds. Pieces of that form are leſs liable to damage the cupell.

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the head, and, having luted it round with ſoft clay, make fire in the fire-hole as for the common operations of refining.

When the lead is in complete fuſion, and the maſs is covered with ſcum and charred ſtraw, make the ſcum or droſs run off by the gutter for the litharge with a bit of board about a foot in length, in the middle of which is faſtened a rod of iron of ſufficient length to traverſe the furnace and about a yard more.

When the lead has been well ſcummed ſeveral times, and begins to be red, make the bellows act, but at firſt gently; arrange the nozzles of them in ſuch a manner, that the wind iſſuing from both may be directed to the centre of the cupell; and in order that the wind may be always reverberated on the maſs, adapt to the extremity of each nozzle a ſmall round piece of iron plate. This kind of valves, which the French refiners call *papillons*, is employed for refining according to the German method. They are ſuſpended by hinges at their upper part: at each ſtroke of the bellows they are half raiſed, and they reverberate the wind on the lead, which accelerates its oxidation.

After all the droſs or ſcum is removed, and when the lead has become exceedingly red, and covered with a ſtratum of litharge, form, with a ſmall iron hook deſtined for that purpoſe, a ſmall gutter in the ſand of the cupell, which muſt be dug deeper, gradually and with caution, until the bottom of it be on a level with the maſs. The litharge then, driven by the wind of the bellows towards the anterior part of the furnace, will run by this gutter and fall on the floor of the foundry, as is the caſe in the common operations of refining.

When the refiner obſerves that no more litharge remains in the neighbourhood of the gutter, he will ſtop the flowing off with a ſmall quantity of moiſtened aſhes: but as ſoon as the lead again becomes covered with oxide, the gutter muſt be opened, and muſt be dug in proportion to the diminution of the maſs, taking care that no lead eſcapes, and particularly towards the end of the operation; for it would carry with it a great deal of ſilver, which would be loſt. You muſt proceed in this manner till the ſilver has acquired its vivid colour; taking care to increaſe the fire in proportion to the diminution of the maſs; eſpecially when the operation is nearly terminated, becauſe the ſilver then is collected together: and, as it is much more difficult to be kept in fuſion than the ſmall quantity of lead which remains united with it, it could be refined only in an imperfect manner at an inſufficient temperature; and inſtead of about a twentieth of lead, which the ſilver generally contains in the German refining-

houſes, it would remain charged with a great deal more, which would render it more difficult to proceed to a ſecond operation, called the *refining of ſilver*, by which it is carried to the required degree of purity. The Germans call this ſecond proceſs *ſilber brennen*, burning ſilver.

Thoſe accuſtomed to the refining of lead according to the German method, will be able to perform that which I here propoſe; for, though the cupell be of ſand inſtead of aſhes, the operation muſt be conducted in the ſame manner.

It has been ſeen that the Engliſh refine a large quantity of lead in a ſmall cupell: in the like manner, a great deal of metal may be made to paſs by that which I propoſe, if care be taken to add more metal as that which is oxidated eſcapes. If we ſuppoſe that the cupell is capable of containing four or five tons of lead, above ſixteen may be refined at one operation; which will not be attended with the inconveniences of the Engliſh proceſs.

I have reaſon to think that a cupell of ſand well conſtructed may ſerve for ſeveral operations without the neceſſity of re-conſtructing it each time, as is the caſe with thoſe of aſhes; but in this caſe, and before the lead is introduced, you muſt fill up the gutter which has been made for the litharge to run off, after having removed with a chiſel the kind of varniſh which the oxide of lead has left on the ſides of it, in order that the new ſand, ſomewhat moiſtened, may form an intimate connection with the old ſand, which muſt alſo be watered in that part before the new ſand is depoſited.

The long duration of earthen ſoles in reverberating furnaces, where lead ore and even litharge are fuſed, as I have already mentioned, leaves no room for apprehenſion in regard to the action of the oxide of lead, which will act only at the ſurface of the cupell, and will penetrate only a very ſmall part of its thickneſs.

After one or more operations of refining, this cruſt muſt be removed, and fuſed in a furnace in contact with fuel, in order to obtain the lead. This proceſs will be as eaſy as the reduction of that metal contained in the aſhes of common cupells, and in a much ſmaller quantity. More litharge then will be obtained by the new method than the old; which is an advantage, as I have already obſerved. I ſhall here add, that as the ſole of ſand does not abſorb ſo much oxide of lead as that of aſhes, it will not carry with it ſo much ſilver; for it is well known that lead revived from its aſhes always contains more than that which ariſes from the reduction of litharge.

Inſtead of ſand, argillaceous earth might be employed for the

the conſtruction of cupells, as is the caſe in regard to the ſoles of the reverberating furnaces in the ci-devant Brittany; but it would be neceſſary to ram this earth repeatedly for ſeveral days; otherwiſe it would ſplit, and theſe cracks would increaſe by the ſhrinking which muſt reſult from the heat, and lead would inſinuate itſelf into theſe fiſſures: an inconvenience which cannot take place with ſand even a little earthy. I ſhall obſerve alſo, that a ſole of earth would harden too much to allow a gutter to be dug for the paſſage of the litharge: in this caſe it would be neceſſary that the place deſtined for the oxide to run off ſhould be conſtructed with ſand or lixiviated aſhes.

I ſhall add alſo, that it will be advantageous to employ two kinds of ſand in the formation of the baſon of the cupell; one kind fine like that uſed by founders, and the other coarſer and not earthy: the latter will form the firſt ſtratum, which, after being beat with rammers deſtined for that purpoſe, ought to be about three inches and a half in thickneſs. The fine ſand, a little earthy, muſt then be applied over this firſt ſtratum to form a ſecond, which is to be rammed like the former. Both theſe kinds of ſand muſt be ſomewhat moiſtened before they are introduced into the furnace, in order that they may be better heaped up, and be conſolidated by the rammers.

The ſand of the lower ſtratum, being coarſer than that of the upper, will abſorb the moiſture of the latter in proportion as it evaporates; and it will paſs without any obſtacle through the canals diſpoſed for that purpoſe.

The lower ſtratum of ſand may remain in its place when a new cupell is to be conſtructed with fine ſand, and the part of the latter, which has not been impregnated with oxide, muſt be mixed with new ſand to form a cupell. Care muſt be taken in raiſing this ſand not to touch the lower ſtratum; for the ſand of the latter, which is coarſe, muſt not be mixed with the other. This inconvenience may be avoided by beating over the bed of coarſe ſand a thin ſtratum of aſhes, at which you muſt ſtop in removing the fine ſand of the upper ſtratum.

It has been ſaid that the founders' ſand muſt be ſomewhat earthy, and that, if it is not, a little argil muſt be added to give it coheſion: but, as it is neceſſary that this argil ſhould be uniformly diffuſed through all the parts of the ſand, it muſt be diluted in the water with which the ſand is moiſtened, and the whole muſt be carefully mixed.

It may be objected, that as cupells of ſand do not abſorb ſo much litharge as thoſe of aſhes, more time will be required to terminate the operation of refining; ſince, in the new proceſs,

cefs, the oxide, inſtead of being abſorbed, ought to flow from the furnace. This circumſtance needs excite no uneaſineſs; for the wind of the bellows, if well directed, will make the litharge flow along the gutter more abundantly than if there had been an abſorption.

I have ſeen refiners in Germany, who, in conſtructing their cupells of aſhes, formed in the middle of it a ſmall circular depreſſion the diameter of which was proportioned to the quantity of the ſilver which they knew to be contained in the lead ſubjected to the operation. By this excellent diſpoſition no grains of that valuable metal remain inſulated from the cake; the whole runs into the central baſon, and forms a cake perfectly round. I would recommend this practice.

I am certain that the cupells here propoſed, if carefully and properly conſtructed, will be attended with complete ſucceſs; will be free from the inconveniences of thoſe of aſhes, and at the ſame time will be economical. I am deſirous, for the benefit of metallurgy, that the method here pointed out may be put in practice: it will prove that we ought not to be too tenacious in adhering ſervilely to antient uſages or to the common routine of workmen.

XXXIII. *On Painting.* *By Mr.* E. Dayes, *Painter* *.

I THINK it right again to repeat, that I have not obſerved any order in the production of theſe Eſſays. They were written as the ſubjects aroſe in my mind, and the preſent paper ſhould be conſidered rather as an introductory addreſs than otherwiſe. My motive in writing the preſent eſſay was to endeavour to remove the prejudice of thoſe who conſider the arts as a uſeleſs ſtudy, and their produce as things merely ornamental. But who, in a ſtate of civil ſociety, would be content with the uſeful or neceſſary? Who is he whoſe ſoul ſeeks not after perfection?

> The motions of his ſpirit are dull as night,
> And his affections dark as Erebus:
> Let no ſuch man be truſted.

The ſubject of the following eſſay had long engaged my attention; but I had dropped the idea of writing on it, in conſequence of ſome intelligent friends obſerving it would be uſeleſs, as no one could be ſo ſtupid as not to ſee the uſefulneſs and influence of the arts on ſociety. Experience,

* Communicated by the Author.

however,

however, has taught the contrary; and I have been further ſtrengthened in my reſolution by obſerving, that the French National Inſtitute, in their public ſitting of April 5, had thought the inquiry of ſufficient importance to offer it as a ſubject for the premium of a gold medal *.

Francis-ſtreet, Bedford-ſquare, November 30, 1802. EDWARD DAYES.

ESSAY VII.

On the Power and Uſefulneſs of Drawing.

I am perſuaded that to be a virtuoſo (ſo far as befits a gentleman) is a higher ſtep towards becoming a man of virtue and good ſenſe, than the being what in this age we call a ſcholar. *Lord Shafteſbury.*

IN this eſſay we have two objects in view: to ſhow the connection of drawing with painting; and to exhibit, in as clear a manner as we poſſibly can, its uſefulneſs and influence on ſociety.

But before we proceed it may be neceſſary to obſerve, that thoſe who would queſtion the utility of the arts, would be equally diſpoſed to queſtion the utility of theſe eſſays that treat about them. Of their uſefulneſs we hope to be able to offer numberleſs proofs; but they riſe ſuperior to the merely uſeful. For that which is neceſſary is neither ornamented nor elegant, becauſe neceſſity implies poverty, while ornament implies abundance. Hence architecture, as an art, does not apply to mere houſe-building.

In defence of theſe eſſays, they are ſerviceable by exhibiting the uſefulneſs of truth; and ſo far they become an object to all thoſe who wiſh to be acquainted with the ſubject handled, and to obtain a knowledge therein. But to thoſe who never think or inquire, or concern themſelves with matters of ſpeculation, or who take up with ſpeculations without examining them, or read only to confirm themſelves in ſuch as they have received, not any thing can become an object of concern, or any book be uſeful.

That man was not intended by nature for purpoſes baſe and ignoble, none will deny; and, if arguments were wanted, they might be drawn from that eternal inquiry after whatever is grand, dignified, or exalted; and, finally, after a ſtate ſuperior to our preſent terreſtrial one. For it is not too much

* We cannot help thinking that Mr. Dayes has judged well in taking up this part of the ſubject. It is of great importance, and he has rendered an eſſential ſervice not only to the art itſelf, but to its liberal profeſſors, by removing, as his arguments effectually do, ill-grounded prejudices againſt its indiſpenſable utility in civilized ſociety; prejudices which could only originate in, and be foſtered by, ignorance and ſtupidity.—ED. TOR.

to

to assert, that we approach the Divinity in nothing so much as in wisdom. Hence, as the arts are connected with wisdom, as men become careless of their culture, they become equally incapable of fulfilling the duties of social beings. For knowledge is what humanizes mankind; reason inclines them to mildness, but ignorance generates prejudice, which eradicates every tender feeling.

By *drawing* is meant the exact imitation of all the forms and manners which present themselves to our sight; and in knowing how to give every thing its proper and corresponding character agreeably to the subject consists the excellence of what the artist terms *a good draftsman*.

Drawing, as far as it is connected with mere imitation, is a mechanical operation, and may be acquired by a person of very moderate talents. So may a knowledge of bodies, properties, facts, events, and fables, by reading. But the powers of invention, the *vis poetica*, which distinguishes the bard from the mere versifier or journalist, the genius from the mere imitator and copyist, must be a gift from heaven bestowed at the formation of the being. Neither this poetic energy nor the inventive powers of the artist can be taught in schools or academies; but they both may be buried in rust and inaction, if proper objects are not presented to call them into motion. So the inventive powers of genius will be futile if unaccompanied by a skill in drawing. Without this, the learning of the painter or sculptor cannot be shown to advantage: it is the *sine qua non* by which all the other accomplishments are displayed.

From what has been already stated, the dependence of painting on drawing must be obvious.

Genius has been compared to fire from flint, which can only be produced by collision: if so, success must follow where nature directs and perseverance attends. Activity is a necessary ingredient to enable us to obtain a knowledge in art; and should we find others out-step us, let us redouble our diligence, and comfort ourselves with the recollection, that a late spring produces the greatest plenty.

No one can possibly judge of his powers from mere speculation; the test must be applied before the value of the gold can be known. Nor will inactivity ever discover how far our fortitude will enable us to overcome difficulties, our patience to bear disappointment, or our industry enable us to range the wide field of art. For, were the arts of easy attainment, they would be unworthy the notice of a great mind. This should induce us to increase our exertions in proportion to our disappointments, remembering that to strive

with difficulties is noble, but to conquer is one of the higheſt points of human felicity. It is in painting as in writing: where difficulties occur, they ariſe from not clearly underſtanding the ſubject. Hence, to be able to repreſent an object juſtly we muſt underſtand its fabrication; for it would be in vain to think of drawing the arch of a bridge correctly without knowing how it was keyed or put together, or even a baſket if we did not know how it was wove.

We ſhall now proceed to conſider the power of drawing in a point of view merely uſeful.

How limited muſt their ideas be who conſider it as "the foundation of painting" only! We know it is ſuch: for without drawing it would be in vain to think of producing an effect; as mere colour without form muſt remain a crude and undiſtinguiſhable maſs.

Drawing is not only an accompliſhment the moſt elegant, agreeable, and ornamental, but, at the ſame time that it is the foundation of painting, is of the utmoſt utility to the ſculptor, the civil and naval architect, the engraver, the engineer, the mathematician, and navigator. It alſo aſſiſts the gardener, the cabinet-maker, the weaver, &c. In ſhort, there is ſcarcely a branch of civil ſociety that is not indebted to it; from the maker of the iron rails before our houſe to the tea-urn on our table. To it we are indebted for repreſentations of thoſe elegant remains of antiquity that have contributed ſo much to the advancement of our knowledge of fine form. Volumes of verbal deſcription will never convey ſo true an idea of a thing as the moſt ſlight ſketch. Hence the ſource of much of our knowledge in antiquity, of which language could convey no adequate idea.

To be able on the ſpot to make a ſketch of a fine building, beautiful proſpect, or any curious production of nature or of art, is not only a very deſirable and elegant accompliſhment, but in the higheſt degree entertaining. To treaſure up whatever may occur in our travels, either for future uſe or to illuſtrate converſation, to repreſent the deeds of the great of former ages, to preſerve the features of our moſt valued friends, has made this art not only one of the higheſt embelliſhments of our nature, but the delight of all ages. The greateſt writers have united to praiſe, and empires to encourage it. It has been in the higheſt degree morally uſeful; and, where it has flouriſhed, conferred honour on the country. In fact, ſociety could not ſuſtain a more ſevere loſs than in being deprived of it; as many comforts, and all thoſe elegancies that adorn the preſent ſtate of our being, muſt depart with it.

What

What has been the fate of thoſe people whoſe lawgivers forbid the practice of one part of the elegant arts? It appears they well knew, that where art reſides, wiſdom will ever be of the party; and dreaded the downfall of opinions built on a falſe baſe.

Wiſdom is power, and power is what preſerves a nation: hence thoſe who ſhut the door againſt knowledge are wilfully ſeeking their own deſtruction: ſuch is preciſely the preſent ſtate of the Turkiſh empire.

> Ye gods! what juſtice rules the ball!
> Freedom and arts together fall:
> Fools grant whate'er ambition craves;
> And men once ignorant are ſlaves. POPE.

What was the fate of Crete, that was ſo renowned for her wiſdom, valour, and laws? How did ſhe ſink under the tyranny and oppreſſion of Rome? With their freedom departed their arts, their ſciences, their valour, and their virtues. With the loſs of liberty we loſe all the ardour nature has furniſhed us with to ſtrengthen and ſupport the flame of genius and the ardent glow of valour: without it we become deſtitute of vigorous reſolution, and ſink below the natural virtue and dignity of our ſpecies.

Drawing may be ſaid to poſſeſs a divine virtue in its creative power, and to be a perpetual miracle, as it preſerves the images of diſtant objects, and the likeneſs of thoſe we love.

Without riſking our lives on the boiſterous ocean, we may enjoy at home, in a ſmall book, repreſentations of the fineſt productions of nature and art ſituated in the remoteſt regions of the world.

The wealth of a ſtate, and the degree of civilization of its inhabitants, are ſhown in the perfection of the elegant arts: no country ever flouriſhed without them.

To ſpeak of the power of drawing in a very limited point of view: without it we could not have maps and charts; without them we could not navigate; and without navigation we could not poſſeſs the advantages of commerce. Its application to ſhip-building muſt be obvious, as every part is made to a ſcale. As a mere power of imitation, it unqueſtionably ſets man at the head of creation, no other animal having made even the attempt.

The arts have not only an influence on our manners but paſſions, and, taken in a national point of view, are highly uſeful. The pictures repreſenting gallant actions or noble achievements rouſe and ſtimulate to acts of heroiſm and

public ſpirit; while thoſe of a more elegant turn exhibit examples of graceful addreſs, and incline the mind to acts of beneficence and virtue.

However much we may lament that hiſtorical painting is not ſufficiently encouraged, yet we muſt diſſent from thoſe who ſupport the old but erroneous opinion, that our love of portrait-painting ariſes from a national vanity. This ridiculous idea has been bandied about, both by foreigner and native, till many who take up with opinions without examining them have believed it true. We boldly aſſert, on the contrary, that it is national virtue that gives it birth, and a deſire the moſt rational, that of preſerving the images of thoſe we love and delight in, conſtantly before our eyes. It argues great national beneficence and goodneſs of heart. We may in ſome meaſure judge of the diſpoſition of the maſter of a houſe from the number of portraits he poſſeſſes: they cannot be likeneſſes of his enemies. Hence his choice muſt be founded on love, and not, as the antients' was, on pride and vanity. The portrait-painter therefore becomes morally uſeful by increaſing that ſocial tie that binds ſociety together, in keeping before our eyes the images of departed worth or exiſting merit. It is only thoſe who neither love nor are beloved, that have no need of the portrait-painter.

Among the number of our own national advantages, and which ſome may think ſuperior to all others, we may obſerve that the excellence of our artiſts has turned the balance of trade in our favour. For whereas we formerly imported vaſt quantities of prints, we now ſupply all Europe, and import very few. Even for the decoration of our books we were formerly obliged to apply to ſtrangers: but Heath has added a taſte to that department of art unknown to former engravers in the hiſtorical line. Among the topographical publications, thoſe prints that accompany the "Beauties of England and Wales" muſt be highly intereſting for taſte and beauty.

In the beginning of the laſt century, the writers on the continent amuſed themſelves in endeavouring to aſſign a cauſe for the dulneſs of us iſlanders in not having produced one hiſtorical painter. Our northern latitude, being involved in fogs, was among the reaſons aſſigned: but the cauſe of ſuch abſurd inquiries has ceaſed, and the mental capacity of Britons no one will now dare to queſtion.

The conſequence of our nation and the arts appear to have advanced together. The firſt is evinced in our colonial poſſeſſions; and if we go back to the time of Henry VIII., we ſhall eaſily diſcover the ſtate of commerce and the comfortleſs ſituation of ſociety compared with the preſent. Hollin-

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ſhed obſerves that chimneys were a novelty, as were pewter ornaments for the table. Straw formed the bed, and a good hard block of wood the pillow. Then was the dawn of the arts. Since which time they have been advancing, and are now, thank God! matured into a glorious mid-day, under the auſpices of his preſent majeſty.

It is impoſſible to ſpeak of the arts without expreſſing our gratitude towards their great patron; and were his name to flouriſh in no other way, that of George III. will be ſacred to poſterity with thoſe of Leo, Julius, and all ſuch as have a claim on eternity, as their protectors. His majeſty has done for the arts what no monarch of this nation ever did before: he has given, by his patronage, a turn to the national taſte highly beneficial to the profeſſion, which the public are bound to ſupport by a liberal and fair encouragement. With reſpect to the mere act of buying, we are bound to conſider his majeſty in the light of a private gentleman, who regulates his expenditure according to his income: and we ought to thank God it is ſo.

Holbein had not taſte enough to change the groteſque faſhions of the court of Henry VIII. He brought about a revolution in architecture; but he introduced a mungrel ſtyle, inferior to the Gothic of that period. Zuccaro was in England in the time of Elizabeth; and during that long reign we find little improvement in architecture, dreſs, or in the general circle of elegancies. It was a court of intrigue and vanity. In the reign of James I. Van Somer and Cornelius Janſon paved the way for Van Dyck—an epoch of taſte; but this appears to have been confined to the court and a few noble collectors; and the troubles of Charles his ſucceſſor prevented his giving them a more general influence. His reign ſtands high in the hiſtory of architecture, from having produced Inigo Jones. Under Lely taſte ſunk into Indian gowns and flowing perukes; till faſhion became a monſter in the time of Kneller, and appeared in buckram coats, ſquare-toed ſhoes, and diſproportioned head-dreſſes in the ladies. This ſtyle of dreſs prevailed till within theſe few years, when good ſenſe and a more juſt taſte broke through the buckram and whalebone, and produced the preſent eaſy and elegant mode of attire; which may be ſaid to mark a point of national excellence. Reynolds contributed much to this change; his whole life was a ſtruggle with the hydra faſhion, as his works evince.

The above ſtatement will be found not to apply only to the article of dreſs, but to extend to every department. Let us, for inſtance, from the period of Henry VIII. examine

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ſhip-building, civil architecture, our furniture, plate, &c. &c., and we ſhall find them to have nearly improved together, or to have fluctuated as the taſte for *deſſin* prevailed, till the patronage beſtowed by his preſent majeſty, by exciting a general love for the arts, improved the national taſte to its preſent great and highly reſpectable ſtate.

Before we diſmiſs the preſent eſſay we ſhall endeavour to point out ſome of the advantages that reſult from the practice of drawing, to thoſe who do not make a profeſſion of it. Many muſt be obvious from the former part of this paper. To every gentleman who travels, it is abſolutely neceſſary; for, independently of its teaching him to ſee accurately, the curious and ever-reſtleſs eye of the artiſt comprehends more at one view than the common obſerver will notice in an age. The volume of nature is laid open to him; his attention is directed to the vaſt and minute; men and manners are not concealed from his view, and his imagination clings to perfection with ineffable delight.

It is not too much to ſay, that drawing opens the mind more than years devoted to the acquiring of languages, or the mere learning of words: it teaches to think. The artiſt is a true logician: not content with producing effects, he is ever inquiring after cauſes founded on a viſible demonſtration, to exhibit them in his works.

We muſt not rank it among the leaſt of the advantages reſulting from the practice of the arts, that it enures the reflecting mind to the moſt enticing ſort of logic. The practice of reaſoning upon objects in themſelves agreeable tends to produce ſuch a habit, and habit ſtrengthens the reaſoning faculties. Beſides, while the mind is engaged in obtaining knowledge, we eſcape the inſipidity and indifference connected with the tediouſneſs of inactivity. Hope attends labour; a bleſſing unknown to thoſe who live lazily on the toil of others. The ſenſualiſt imagines he enjoys the world becauſe he eats and drinks, and runs about upon it; but to enjoy it truly, is to be ſenſible of its greatneſs and beauty.

Independently of keeping the mind employed, the arts contribute to harmonize the temper; and the power of drawing brings with it ſo much mental enjoyment, that youth, in order to be occupied, is not tempted to precipitate into the ruinous and deſtructive vices of gaming and drinking. It defends us in the meridian of life from the wild ſchemes of ambition, and in old age it becomes a ſure ſhield againſt avarice. Shenſtone obſerves, "Wherever there is a want of taſte, we generally obſerve a love of money and cunning."

The influence it has on our moral conduct is, perhaps, one of the greateſt recommendations for the ſtudy of the arts. No one can meditate on the order obſervable in nature, and not reduce his conduct to a ſimilar ſtandard of regularity. To have a juſt reliſh for what is elegant and proper in painting, ſculpture, or architecture, muſt be a fine preparation for true notions relative to character and behaviour. Should ſuch a one be overpowered by paſſion, or ſwerve from his duty, we need not fear but he will return on the firſt reflection, and with a redoubled reſolution not to err a ſecond time: for he cannot but obſerve, that the well-being of nature, as well as of the individual, depends on regularity and order; and that a diſregard of the ſocial virtues will ever be accompanied with ſhame and remorſe. Paſſion is a whirlwind, that ſhakes the human frame, as the convulſions of an earthquake diſorder that of nature.

Every Briton that travels ſhould propoſe to himſelf pleaſure and advantage, and his inquiry ſhould enable him to add to the national ſtock of knowledge; for it cannot be ſaid that he travels to enjoy the advantage of a better government, or becauſe other nations have a greater commerce. Hence, then, it muſt be for arts and learning. And how is he to become acquainted with the former without a knowledge in painting, ſculpture, and architecture, any more than he could with the latter, without a knowledge in the languages of the countries he may have occaſion to paſs through? Lord Bacon ſays: "Travel, in the younger ſort, is a part of education; in the elder, a part of experience. He that travelleth into a country before he hath ſome entrance into the language, goeth to ſchool and not to travel." The ſame may be ſaid of thoſe who travel before they have obtained a knowledge in the polite arts. How many noble works of architecture did lord Burlington bequeath to his country! They remain monuments of national taſte, highly honourable to his memory. Let us be permitted to mention the honour the arts at preſent derive from the maſterly productions of the earl of Aylesford, ſir G. Beaumont, ſir R. Hoare, W. Scope, eſq. of Caſtle-comb; captain Lewis, of the royal navy; capt. Mordaunt, and many others, whoſe works will ever rank among the firſt productions of the pencil. Lord Warwick is ſaid to poſſeſs the true poetic ſpirit for compoſing heroic landſcape. While we are recommending to gentlemen to learn to draw, it muſt not be underſtood that we wiſh to deprive the ladies of the pleaſure and advantage that muſt reſult from their practiſing an art that ſtands, perhaps, before all others for improving

improving our taſte, particularly in ſuch things as are connected with decoration.

Though we recommend learning to draw thus generally, we muſt ſay it requires the utmoſt caution in the choice of a maſter; for, ſhould his abilities be confined, or his taſte depraved, there is great danger of the poiſon being conveyed to the pupil: and if, in the end, his better underſtanding riſe ſuperior to the evil, he will, unfortunately, have much to unlearn. Above all, if he be arrived at an age to diſcriminate, objects worthy attention ſhould be ſet as examples of imitation; he ſhould not be amuſed and his time waſted with gew-gaws and traſh beneath the dignity and attention of rational beings.

Every one is acquainted with the progreſs of what may be termed common or ſchool education. The maſters begin teaching the letters, and then proceed to ſyllables, which are joined into ſentences: but the ultimate end is, compoſing themes to call forth the power of invention, and convey a more exquiſite idea of the language. Exactly ſo ſhould be the progreſs in teaching drawing. If the knowledge to be obtained be the human figure, we begin with parts; as eyes, noſes, heads, hands, &c., which is the A B C. This, of courſe, leads to the whole figure, which may be compared to ſpelling; that naturally conducts to the round, or drawing from plaiſter caſts; then from the life; and ultimately to compoſition. Should landſcape be the purſuit, the progreſs is preciſely the ſame. We begin with parts or ſingle objects; as trees, bridges, cottages, caſtles, &c. Here again is the alphabet. This we too quit to copy wholes, or a combination of objects; and in the end we apply to nature, which ſets us free from our maſter. Then we muſt improve by our own activity; and, like the bee, cull the honey from every flower. As much of our ſucceſs depends on the abilities of the maſter, the greateſt care ſhould be obſerved in the choice. He is but as a crutch to the lame; but we ought to make ourſelves ſure it is ſound, and without flaw or ſhake; that is, as far as our judgment will permit, or the opinion of friends direct.

He who aſpires to a knowledge in the fine arts can only hope to ſucceed by turning his attention to the ſenſitive part of nature, particularly by an inquiry after ſuch objects as are naturally agreeable, or the contrary: alſo ſuch as are grand or mean, proper or improper. This is the only foundation of a juſt and rational taſte, and, like morals, may be cultivated to a high degree of refinement. The fine arts, where the feelings only are concerned, will pleaſe, from their no-

velty, in the prime of life; but the delight will ceaſe in a more advanced period, when the fervour of the imagination goes off. On the contrary, where we are governed by juſt principles and a thorough knowledge, they will afford ſcope for fancy as well as judgment, they will grow into a favourite entertainment, and their vigour will prevail as ſtrong in the evening as in the morning of life. This only can make the arts truly delightful. It is not a few technical phraſes, picked up from profeſſional men, which may enable one to babble like a parrot, that can at any time pleaſe or be pleaſing. Science is a coy lady, and will not grant her favours without being long courted. But, ſhould we aſpire to no higher character than that of the mere critic, a ſmall ſtock of information will ſuffice; and practice will increaſe confidence where there is nothing to loſe. Criticiſm is a lady of eaſy acceſs: the want of meaning ſhe ſupplies with words; and the want of knowledge is recompenſed with cunning. She flatters all; and thoſe whom nature has made weak, or idleneſs keeps ignorant, may feed their vanity at her ſhrine.

XXXIV. *On the Differences which exiſt between the Heads of the Mammoth and Elephant. By* REMBRANDT PEALE, *Eſq.**

THE drawings which accompany this (ſee Plate V.) are intended to explain the differences between the head of the mammoth and that of the elephant. The teeth form the moſt ſtriking character: thoſe of the elephant are excluſively graminivorous, and conſequently diſtinguiſhed from thoſe of the mammoth, which were intended for animal food of ſome kind, and not improbably ſhell-fiſh, on the ſuppoſition that the animal was amphibious†: and this may account for the peculiar form and poſition of the tuſks. On examining the head of the elephant, it will appear that the ſockets for the tuſks at A are ſituated, with reſpect to the condyle of the neck at B, nearly in an angle of 45 degrees; ſo that the tuſks, which have but little curve, are directed downwards and forwards, and may be with eaſe employed offenſively and defenſively. On the other hand, it will be obſerved that in the mammoth the ſocket A is nearly on a horizontal line with the condyle B; and therefore the tuſks, which are ſemicircular, could never have been elevated in the air, pointing

* Communicated by the Author.

† See the former number, p. 162—169 of the preſent volume.

backwards,

backwards, but muſt have been as repreſented in the figure, the points thrown out by the ſpiral twiſt on each ſide:—in this poſition they might have anſwered in ſtriking down ſmall animals, or in detaching ſhell-fiſh from the bottoms of rivers, or even in aſcending the banks.

In the elephant the orbit of the eye is ſituated at C, whereas in the correſponding part at C in the mammoth is a large maſs of bone, ſo that the eye muſt have been elſewhere: to aſcertain where, we muſt wait until we receive the cranium lately diſcovered on the Ohio. The cheek of the elephant is formed of two bones; but in the mammoth, beſides other variations, there is but one bone. The whole figure of the under-jaw differs moſt remarkably; firſt in the length of the condyles or arms from E to B: in the mammoth it is ſhort and angular; but in the elephant D E B forms a ſemicircular line, and at D it is long and pointed.

This ſhort reference is ſufficient to direct the attention of thoſe who wiſh to examine them more critically; when they may remark ſeveral other characters ſufficiently intereſting.

XXXV. *On the Hydrometer. By* WILLIAM SPEER, *Eſq. Surveyor and Aſſayer of Spirits in the Port of Dublin.*

[Concluded from p. 162.]

I SHALL now proceed to explain Mr. Gilpin's tables, in order to demonſtrate their uſe, and the uſe of my additional columns. The firſt I cannot do better than in the words of Sir Charles Blagden himſelf:

"Tables for reducing the quantities by weight, in any mixture of pure ſpirit and water, to thoſe by meaſure; and for determining the proportion, by meaſure, of each of the two ſubſtances in ſuch mixtures, by Mr. George Gilpin, clerk to the Royal Society, communicated by Sir Charles Blagden:

"Theſe tables are founded on the experiments, of which the reſults were given in the Report and Supplementary Report on the beſt Method of proportioning the Exciſe on Spirituous Liquors. They are computed for every degree of heat, from 30° to 80°, and for the addition or ſubtraction of every one part in a hundred of water or ſpirit; but as the experiments themſelves were made only to every fifth degree of heat, and every five in the hundred of water or ſpirit, the intermediate places are filled up by interpolation in the uſual manner, with allowance for ſecond differences.

" Every table conſiſts of eight columns, and there are two tables for every degree of heat. In the firſt column of the *firſt* of the two tables are given the proportions of ſpirit and water by weight, 100 parts of ſpirit being taken as the conſtant number, to which additions are made ſucceſſively of one part of water, from 1 to 99 incluſively: the firſt column in the ſecond table has 100 parts of water for the conſtant number, with the parts of ſpirit decreaſing ſucceſſively by unity, from 100 to 1 incluſively.

" It muſt be obſerved, that each of theſe tables, occupying one page, is divided in the middle for adapting it more conveniently to the ſize of the paper; but the whole of each page is to be conſidered as one continued table. The ſecond column of all the tables gives the ſpecific gravities of the correſponding mixtures of ſpirit and water in the firſt column, taken from the table of ſpecific gravities in the Supplementary Report, the intermediate ſpaces being filled up by interpolation. In the third column, 100 parts by meaſure of pure ſpirit, at the temperature marked at the top of every ſeparate table, is aſſumed as the conſtant ſtandard number, to which the reſpective quantities of water by meaſure, at the ſame temperature, are to be proportioned in the next column.

" The fourth column, therefore, contains the proportion of water, by meaſure, to 100 meaſures of ſpirit, anſwering to the proportions by weight in the ſame horizontal line of the firſt column. The fifth column ſhows the number of parts which the quantities of ſpirit and water, contained in the third and fourth columns, would meaſure when the mixture has been completed; that is, the bulk of the whole mixture after the concentration or mutual penetration has fully taken place. The ſixth column, deduced from the three preceding ones, gives the effects of that concentration, or how much ſmaller the volume of the whole mixture is, than it would be if there was no ſuch principle as the mutual penetration. The ſeventh column ſhows the quantity of pure ſpirit by meaſure, at the temperature in the table, contained in an hundred meaſures of the mixture laid down in the fifth column."

From this account it will be ſeen, that every mixture of pure ſpirit and water poſſible to be made, is analyſed ſo clearly at every temperature, as to render it a matter of no great difficulty to demonſtrate, at a given temperature, all the gradations of ſtrength which the hydrometer ſhould indicate. The mode in which this has been done I ſhall now explain.

The table which Mr. Gilpin has calculated for the temperature of 55, is that which I have choſen, conceiving it,

for ſeveral reaſons, to be the moſt convenient. And as a reference to it becomes neceſſary, I have annexed this; with the additional columns to it, by which the hydrometer indications of ſtrength are regularly deduced from the ſpecific gravity of the ſpirit at this temperature *.

In order to explain the manner in which I have calculated theſe additional columns, I conceive the eaſieſt mode will be by an example.

It being underſtood by the trade that the ſpecific gravity of proof ſpirit at this temperature (55) is 922, I look at the table for this ſpecific gravity, and I find that it is a mixture of pure ſpirit and water, in the following proportions, viz. 100 parts of the former to 81 of the latter (both by weight), but that by meaſure it is made by mixing 100 gallons of pure ſpirit with 66 gallons 99 parts of water. I then find that the diminution of bulk, by penetration, on the mixture by meaſure, (that by weight being unneceſſary to attend to in bringing out the reſult,) is 4 gallons 57 parts, as, inſtead of producing 166 gallons 99 parts, there will be only 162 gallons 42 parts. I find next, that this mixture contains per cent. of pure ſpirit 61 gallons 57 parts.

Theſe being the proportions in the ſtandard of proof, to which every other gradation of ſtrength is relative, the Rule of Three demonſtrates this relation in a manner requiring to be explained by another example. Suppoſe a ſpirituous liquor is produced to aſcertain the hydrometer indication; on weighing it in a phial adapted to this purpoſe, I find that at the temperature of 55, its ſpecific gravity is 848; by looking into the table I perceive that this contains per cent. 93·18 of pure ſpirit. I then try how much more than proof this is by ſubtracting 61·57 (the quantity which proof contains), and I find that this has a redundance of pure ſpirit, amounting to 31·61.

Therefore, as 100 gallons of pure ſpirit require 66 gallons 99 parts of water to reduce it to proof, the redundant 31·61 will require 21·17. Add theſe, and from the amount 52·78 the diminution of bulk by penetration is to be deducted, which, by the ratio in proof ſpirit being 1·44, the reſult finally comes out that this ſpirit is 51 gallons and 34 parts (about one-third) over hydrometer proof. The under proofs require leſs calculation, the exceſs of water per cent. over the proportion which proof contains being all that is required.

* It may perhaps be neceſſary to obſerve here, that a reference to this table is not required in the uſe of the hydrometer I have conſtructed, further than to try whether it be correct.

Theſe examples are, I hope, ſufficient to explain this table. The uſes to which it is applicable, are, that *as it affords firſt an unequivocal ſtandard for every gradation of ſtrength*, an hydrometer can be graduated on a certain principle; and, ſecondly, the errors of thoſe that are graduated otherwiſe may be diſcovered by it, and we ſhall no longer be obliged to rely on a mere aſſertion, that the inſtrument is correct, nothing more being required than to compare the ſpecific gravity of the ſpirit with the indication of ſtrength which it has demonſtrated.

On conſidering how far it might be practicable to ſimplify the hydrometer, I perceived that the makers of theſe inſtruments had fallen into two errors, which had very conſiderably increaſed the neceſſity for thoſe complex additions with which they are incumbered.

Firſt, conceiving that the inſtrument was to be valued in proportion as it was capable of making *minute* diſcriminations, (or of its ſenſibility as it is called,) they have, by attempts to increaſe this beyond thoſe limits required either in revenue or in commerce, deſtroyed its ſimplicity.

In the conſtruction of this inſtrument, the proportion of the ſtem to the ball is an important conſideration: if the former be too large, the inſtrument will not be ſufficiently ſenſible; and ſhould it, on the contrary, be too ſmall, the number of gradations of ſtrength it is capable of indicating will proportionably be diminiſhed.

Thoſe who have conſtructed moſt of the hydrometers now in uſe, have run into the latter error; the ſtem being diminiſhed to a ſize which rendered it neceſſary to have recourſe to complex additions to ſupply the place of this injudicious and unneceſſary waſte of the ſimple and proper power of the inſtrument.

From a great variety of experiments to aſcertain the proper proportion between the ball and ſtem, I was finally ſatisfied that the latter would admit of ſuch enlargement as to be rendered capable of meaſuring upwards of 66 gradations or percentages of ſtrength, without any weight; and this ſo clearly and diſtinctly, as to convince me that its ſenſibility and accuracy were ſtill fully ſufficient.

The ſecond error alluded to has ariſen from an attempt to extend the power of the inſtrument beyond thoſe limits, which, with propriety, and conſiſtently with its ſimplicity, could be effected.

An hydrometer being a counterpoiſe to aſcertain the weight of a ſpirituous liquor, may, with propriety, be compared to a

pair of ſcales *, of which there are various *ſizes* and *deſcriptions*, to anſwer *different purpoſes*, by which means their ſimplicity is uniformly preſerved.

On the contrary, it has erroneouſly been conceived, that an hydrometer would be imperfect that did not, *by one means or another*, aſcertain the ſpecific gravity of all liquids at their various temperatures: the ſimple power of every inſtrument of this kind being confined within certain limits, this could not be effected without additional complications of various kinds to thoſe which were added, to increaſe its ſenſibility, ſome of which are certainly ingenious, but, I conceive, highly unfit for the purpoſe of revenue.

Should this ingenuity be exerciſed on a pair of ſcales, which it would be proper to uſe in weighing a portion of eight or ten pounds, and by complex additions render them ſufficiently ſenſible to aſcertain a few grains or fraction of a grain, or ſo extended in their power as to weigh 100 pounds, is it not evident that the ſimplicity of the balance, which is its great recommendation, would be deſtroyed?

That which led to the conſtruction which I finally fixed on, was firſt a *quadrangular ſtem*, from which I had four temperatures, viz. 35, 45, 55, and 65; and the intermediate degrees I managed with four ſmall weights on the top of the ſtem, each ſerving for two degrees of temperature. The inſtrument having been graduated with theſe on, if the temperature ſhould be *two* degrees higher than the ſcale, I removed one weight, in order to lighten the inſtrument equal to the decreaſe of ſpecific gravity; if *four* degrees, I removed two weights; if *ſix* degrees, I removed three weights; and if *eight* degrees, I removed the fourth; and two degrees more brought me to a new ſcale, or ſide of the ſtem: by this means the inſtrument would accord with the variations ariſing from temperature, ſo far as at moſt to be but one degree different from it. It was adjuſted at every tenth degree of temperature.

This was evidently a conſiderable progreſs towards the object I was in purſuit of, as it not only remedied the great defect of inattention to temperature which took place in the Iriſh hydrometer, but, in a great meaſure, the various defects of the Engliſh revenue hydrometer, as, notwithſtanding the weights were reduced from 36 to 4, it accorded nearly with

* The name of the inſtrument, which in ſtrictneſs ſhould be areometer, (hydrometer being an inſtrument for weighing water), demonſtrates this to be the principle on which it acts; therefore in France it is called *peſe liqueu*, and by ſome Engliſh writers, a water-poiſe.

the

the various temperatures, and indicated 66 gradations of ſtrength. I perceived, therefore, that the principle would anſwer, but that it could be improved ſtill further; and after various efforts I at length fixed on that conſtruction, of which I ſhall now beg leave to give a deſcription.

This new hydrometer is made of hard braſs: the ball is ſhaped in the form of a pear, being nearly two inches in diameter at its greateſt dimenſion, and two inches and a quarter in length: the lower ſtem meaſures one inch and a half, and is in ſhape a priſm, each ſide meaſuring one-eighth of an inch: to the lower end of this a round weight is fixed, the diameter of which is ſeven-eighths of an inch. The upper ſtem is in length five inches and a half, and is an octagon, each ſide being ſomewhat leſs than an eighth of an inch wide: each of theſe ſides is graduated for a temperature engraved on the top, the loweſt being 35, the ſecond 40, and ſo increaſing by five until it reaches 70. The zero, or proof point, is marked ⊙, and the gradations of ſtrength (numbered at every fourth) amount to ſixty-ſix, and thoſe ſo clearly diſtinct, that at the over-proofs they will admit of a ſub-diviſion, and by that means indicate a half per cent. Theſe diviſions are not at equal diſtances; an error which takes place in the preſent Iriſh and ſeveral of the old hydrometers, but widen in proportion as the ſpecific gravity of the ſpirit diminiſhes; and, being graduated with ſpirits of known ſtrengths at every four per cent., the intermediate per centages are adjuſted by interpolation.

To prevent any error which might ariſe from taking the indication of ſtrength from the wrong ſide of the ſtem, an index is applied on the top of it, with an opening to ſhow the figures which point out the temperature. This index, which applies *merely* to the purpoſe here mentioned, may be removed lower to any part of the ſtem, but above the ſurface of the liquor, without affecting the accuracy of the inſtrument, as neither its weight nor dimenſion is changed; and being of a different colour from the ſtem (ſanguined ſteel) it forms a contraſt with it, and, as it were, points to the indication ſought for, by which every danger of error in this reſpect is removed.

Although this is the only uſe of the index, when the temperature ſhall be found one of thoſe eight marked on the ſtem, yet it is neceſſary that the inſtrument ſhall accord with the four intermediate degrees between each of the adjoining ſides: for this purpoſe one of two other indexes of different weights are occaſionally ſubſtituted for the firſt one, in order to lighten the

the inſtrument ſo as to accord with the decreaſe of gravity which takes place in the ſpirit by the increaſe of temperature. Therefore the manner of uſing the inſtrument is as follows:

Suppoſing the temperature to be 50, nothing further is required but to place the index No. 1 (each being marked ſo as eaſily to be diſtinguiſhed) on the ſide marked 50, and immerſe the inſtrument, which at once ſhows the ſtrength. Should the temperature be 51 or 52, inſtead of index No. 1, uſe that marked No. 2: ſhould it be 53 or 54, uſe index No. 3: the inſtrument having been adjuſted with theſe two auxiliary indexes, in the one caſe at a temperature of $51\frac{1}{2}$, and in the other $53\frac{1}{2}$, theſe four intermediate temperatures are ſo accorded to, as to be either the actual one, or within *half a degree* of it. And they apply in all caſes, to the four intermediate degrees of temperature, and no other appendage required to enable the inſtrument, in this plain and ſimple manner, to meaſure ſixty-ſix gradations of ſtrength with an accuracy which, it is preſumed, is fully ſufficient for either revenue or commerce *. No weight requiring different immerſions to find out that which is the proper one; no temperature omitted to create doubts, or falſe indications of ſtrength; no fraction in the per centage to operate either againſt the revenue or the merchant; no gradation of ſtrength left unaſcertained or determined by conjecture; no doubt remaining as to the correct ſtrength of all the various gradations; and no ſecond inſpection and ſubſequent combination to be made, requiring the aid of, and liable to the errors of, a ſliding rule.

The following is a table for graduating hydrometers on a certain and invariable principle, ſhowing from the ſpecific gravity of the ſpirit at the temperature 55, what the hydrometer indication of ſtrength ſhould be of every poſſible mixture of pure ſpirit (or alcohol) and water, from the former down to proof ſpirit.—N. B. This table is calculated on the *ſuppoſition* that the ſtandard of proof is 922, temperature 55.

* Even this half degree of temperature may be obtained by holding the jar containing the ſpirit for a few moments in the hand.

Table

I. Spirit & water by weight.	II. Specific gravity at 55.	III. Spirit by measure	IV. Water by measure	V. Bulk of mixture	VI. Diminution of bulk, or concentration.	VII. Quantity of pure spirit, per cent.	VIII. Pure spirit per cent. redundant.	IX. Water to reduce redund. spirit to proof	X. Diminution of bulk on red. spirit & water	XI. Per Cent over Hydrometer proof.
Sp. + W.										
100 + 0	,82736	100		100,00		100,00	38,43	25,74	1,75	62,42
1	,82967		0,83	100,72	0,11	99,20	37,72	25,26	1,72	61,26
2	,83192		1,65	101,44	0,21	98,58	37,01	24,79	1,69	60,11
3	,83412		2,48	102,16	0,32	97,88	36,31	24,32	1,65	58,98
4	,83626		3,31	102,89	0,42	97,19	35,62	23,86	1,62	57,86
100 + 5	,83834		4,93	103,62	0,51	96,50	34,03	23,30	1,59	56,73
6	,84037		4 16	104,36	0,60	95,82	34,25	22,94	1,56	55,63
7	,84235		5,79	105,10	0,69	95,15	33,58	22,49	1,53	54,54
8	,84429		6 62	105,84	0,78	94,49	32,92	22,05	1,50	53,47
9	,84618		7,44	106,58	0,86	93,83	32,26	21,61	1,47	52,40
100 + 10	,84802		8,27	107,32	0.95	93,18	31,61	21,17	1,44	51,34
11	,84982		9.10	108,07	1,03	92,54	30,97	20,74	1,41	50,30
12	,85158		9,92	108,81	1,11	91,90	30,33	20,31	1,38	49,26
13	,85330		10,75	109,56	1,19	91,27	29,70	19,89	1,35	48,26
14	,85499		11,58	110,32	1,26	90.65	29,08	19,47	1,32	47,23
100 + 15	,85664		12,41	111,07	1,34	90,03	28,46	19,06	1,30	46,22
16	,85825		13,23	111,82	1,41	89,43	27,86	18,66	1,27	45,25
17	,85984		14,06	112,58	1,46	88,83	27,26	18,26	1,24	44,28
18	,86139		14,89	113,34	1,55	88,23	26,66	17,85	1,21	43,30
19	,86292		15,71	114,09	1,62	87,64	26,07	17,46	1,19	42,34
100 + 20	,86441		16,54	114,86	1,68	87,06	25,49	17,07	1,16	41,40
21	,86588		17,37	115,62	1,75	86,49	24,92	16,69	1,13	40,48
22	,86732		18,19	116,38	1,81	85,93	24,36	16,31	1,11	39,56
23	,86874		19,02	117,14	1,88	85,37	23,80	15,94	1,08	38,66
24	,87013		19,85	117,90	1,95	84,82	23,25	15,57	1,06	37,76
100 25	,87150		20,68	118,67	2,01	84,27	22,70	15,20	1,03	36,87
26	,87284		21,50	110,43	2,07	83,73	22,16	14,84	1,01	35,99
27	,87415		22,33	120,20	2,13	83,19	21,62	14,48	1,98	35,12
28	,87544	100	23,16	120,97	2,19	82,66	21,09	14,12	0,96	34,25
29	,87671		23,98	121,74	2,24	82,14	20,57	13,77	0,93	33,41
100 + 30	,87796		24,81	122,51	2,30	81,63	20,06	13,43	0,91	32,58
31	,87919		25,64	123,28	2,36	81,12	19,55	13,09	0,89	31,75
32	,88040		26,46	124,05	2,41	80,62	19,06	12,76	0,87	30,94
33	,88160		27.29	124,82	2,47	80,12	18,55	12,42	0,84	30,13
34	,88277		28,12	125,59	2,53	79,63	18,06	12,09	0,82	29,33
100 + 35	,88393		28,95	126,36	2,59	79,14	17,57	11,77	0,80	28,54
63	,88507		29,77	127,13	2.64	78,66	17,09	11,44	0,78	27,75
37	,88619		30,60	127,90	2,70	78,18	16,61	11,12	0,76	26,97
38	,88729		31,43	128,68	2,75	77,71	16,14	10,81	0,74	26,21
39	,88838		32,25	129,45	2,80	77,25	15,68	10,50	0,71	25,47
100 + 40	,88945		33,08	130,23	2,85	76,79	15,22	10,19	0,69	24,72
41	,89051		33,91	131,00	2,91	76,33	14,76	9,88	0,67	23,97
42	,89155		34,74	131,77	2,97	75,88	14,31	9,58	0,65	23,24
43	,89258		35,56	132,55	3,01	75,44	13,88	9,29	0,63	22,54
44	,89359		36,39	133,33	3,06	75,00	13,43	8,99	0,61	21,81

I. Spirit & water by weight.	II. Specific gravity at 55.	III. Spirit by measure.	IV. Water by measure.	V. Bulk of mixture.	VI. Diminution of bulk or concentration.	VII. Quantity of pure spirit per cent.	VIII. Pure spirit per cent. redundant.	IX. Water to reduce redund. spirit to proof	X. Diminution of bulk on red. spirit & water	XI. Per cent. over Hydrometer proof.
Sp. + W.										
100 + 45	,89458		37,22	134,11	3,11	74,57	13,00	8,70	0,59	21,11
46	,89556		38,04	134,88	3,16	74,14	12,57	8,42	0,57	20,42
47	,89653		38,87	135,66	3,21	73,71	12,14	8,13	0,55	19,72
48	,89748		39,70	136,44	3,26	73,20	11,72	7,85	0,53	19,04
49	,89841		40,52	137,22	3,30	72,88	11,31	7,57	0,51	18,37
100 + 50	,89933		41,35	138,00	3,35	72,47	10,90	7,30	0,49	17,71
51	,90023		42,18	138,78	3,40	72,06	10,49	7,02	0,47	17,04
52	,90111		43,01	139,56	3,45	71,65	10,08	6,75	0,46	16,37
53	,90198		43,83	140,34	3,49	71,25	9,68	6,48	0,44	15,72
54	,90283		44,66	141,13	3,55	70,86	9,29	6,22	0,42	15,09
100 + 55	,90367		45,49	141,91	3,58	70,47	8,90	5,96	0,40	14,46
56	,90450	100	46,31	142,70	3,61	70,08	8,51	5,70	0,38	13,83
57	,90531		47,14	143,48	3,66	69,69	8,12	5,43	0,37	13,18
58	,90611		47,97	144,27	3,70	69,31	7,74	5,18	0,35	12,57
59	,90690		48,79	145,05	3,74	68,94	7,37	4,93	0,33	11,97
100 + 60	,90768		49,62	145,84	3,78	68,57	7,00	4,68	0,31	11,37
61	,90845		50,45	146,63	3,82	68,20	6,63	4,44	0,30	10,77
62	,90921		51,28	147,42	3,86	67,83	6,26	4,19	0,28	10,17
63	,90996		52,10	148,20	3,90	67,48	5,91	3,95	0,26	9,60
64	,91070		52,93	148,99	3,94	67,12	5,55	3,71	0,25	9,01
100 + 65	,91144		53,76	149,78	3,98	66,77	5,20	3,48	0,23	8,45
66	,91217		54,58	150,57	4,01	66,42	4,85	3,24	0,22	7,77
67	,91289		55,41	151,35	4,06	66,07	4,50	3,01	0,20	7,31
68	,91361		56,24	152,14	4,10	65,73	4,16	2,78	0,18	6,76
69	,91432		57,07	152,93	4,14	65,39	3,82	2,55	0,17	6,20
100 + 70	,91502		57,89	153,71	4,18	65,06	3,49	2,33	0,15	5,67
71	,91571		58,72	154,50	4,22	64,73	3,16	2,11	0,14	5,13
72	,91639		59,55	155,29	4,26	64,40	2,83	1,89	0,12	4,60
73	,91706		60,37	156,08	4,29	64,07	2,50	1,67	0,11	4,06
74	,91772		61,20	156,87	4,33	63,75	2,18	1,45	0,08	3,55
100 + 75	,91837		62,03	157,66	4,37	63,43	1,86	1,24	0,08	3,02
76	,91901		62,85	158,45	4,40	63,11	1,54	1,03	0,07	2,50
77	,91963		63,68	159,24	4,44	62,80	1,23	0,82	0,05	2,00
78	,92024		64,51	160,04	4,47	62,49	0,92	0,61	0,04	1,49
79	,92085		65,34	160,83	4,51	62,18	0,61	0,40	0,02	0,99
100 + 80	,92145		66,16	161,62	4,54	61,87	0,24	0,16	0,01	0,39
81	,92205		66,99	162,42	4,57	61,57	0.00	0,00	0,00	Proof

N. B. When this Table shall be finally calculated, the fractions in the second and last column are to be rendered into whole numbers.

XXXVI. *Memoir on the Supply and Application of the Blow-pipe. By Mr.* ROBERT HARE *jun. Member of the Chemical Society of Philadelphia* *.

THE blow-pipe is, on many occaſions, an uſeful inſtrument to the artiſt and philoſopher. By the former it is uſed, for the purpoſe of enamelling, to ſoften or ſolder ſmall pieces of metal, and for the fabrication of glaſs inſtruments: while the latter can, by means of it, in a few minutes, ſubject ſmall portions of any ſubſtance to intenſe heat; and is thereby enabled to judge of the advantage to be gained, and the method to be purſued, in operations on a larger ſcale. The celebrated Bergman has amply diſplayed the utility of this inſtrument in docimaſtic operations; and with the perfection of the docimaſtic art the improvement of metallurgy is intimately connected. It is by means of the blow-pipe that glaſs tubes are moſt conveniently expoſed to the heat neceſſary to mould them into the many forms occaſionally required for philoſophical purpoſes; and by the various application of tubes thus moulded, ingenuity is often enabled to ſurmount the want of apparatus, which is the greateſt obſtacle to the attainment of ſkill in experimental philoſophy.

To all the purpoſes which I have mentioned the blow-pipe is fully adequate, when properly ſupplied with air, and applied to a proper flame: but it appears that the means which have hitherto been employed to accompliſh thoſe ends are all faulty.

The moſt general method is that of ſupplying this inſtrument with the breath. In addition to the well-known difficulty of keeping up a conſtant emiſſion of air during reſpiration, and its injurious effect on the lungs †; it may be remarked, that as the breath is deprived of part of its pure air, is mixed with carbonic acid gas, and loaded with moiſture, it is not the moſt fit for combuſtion; and the obvious impoſſibility of ſupporting a flame with oxygen gas, by this method, is alſo worthy of conſideration.

Another way of ſupplying the blow-pipe with air, is that of affixing to it a ſmall pair of double bellows. A contrivance of this kind poſſeſſes obvious advantages over the mouth blow-pipe; but, owing to the pervious nature of the materials of which bellows are conſtructed, and the difficulty of

* Publiſhed by order of the Society.

† In conſequence of this, ſome artiſts have abandoned the uſe of the inſtrument.

making

making their valves air-tight, upwards of nine-tenths of the air drawn into them escapes at other places than the proper aperture. A pair of bellows of this kind, belonging to an artist of this city, which were considered as unusually air-tight, were found to discharge the complement of their upper compartment in six-fourths of a minute, when the orifice of the pipe was open; and in seven-fourths of a minute when it was closed. Hence it appears, that six-sevenths of the air injected into the upper compartment escaped at other places than the proper aperture; and if to this loss were added that sustained by the lower compartment, the waste would be found much greater. As in operating with these machines, it is necessary constantly to move the foot, the operator cannot leave his seat; and, in nice operations, the motion of his body is an inconvenience, if not a source of failure. Bellows of this kind cannot be used for supplying combustion with oxygen gas; because, as this air is only to be obtained by a chemical process, the smallest waste of it is of serious consequence; and as there is always a portion of air remaining in them, even when the boards are pressed as near to each other as the folding of the leather will permit, any small quantity of oxygen gas which might be drawn into them would be thereby contaminated.

It seems that the only instrument hitherto used for the supply of combustion with oxygen gas, is the gasometer of the celebrated Lavoisier: but this machine, although admirably calculated for the purposes of that great philosopher, is too unwieldy and expensive for ordinary uses.

Being sensible of the advantage which would result from the invention of a more perfect method of supplying the blow-pipe with pure or atmospheric air, I was induced to search for means of accomplishing this object. Having observed the cheapness, strength, and tightness, of coopers' vessels, I became desirous of forming an apparatus for my purpose, by means of hydrostatic pressure exerted within them. I soon found that this could not be effected conveniently without the use of leather. Obliged to resort for assistance to this material, I endeavoured to apply it in such manner, as to remedy the evils resulting from the use of it in the common kinds of bellows. The causes of these evils appeared to be, the opening of the pores and joints of these instruments by dryness, and the tension to which they are so frequently subjected. I therefore determined to subject the leather which I should use, to moisture and compression. In this I succeeded, and derived the expected advantage from success. The result of

my

my attention to this subject is the production of a machine, of which there follows an engraving and description.

When it was first shown to the gentlemen of the Chemical Society, some of them bestowed on it the appellation of *gasometer*; but, as etymology does not authorize this name, it has been changed for that of *hydrostatic blow-pipe*.

Fig. 1. (see plate VI.) is a perspective engraving of the hydrostatic blow-pipe. Part of this figure is made transparent, that the internal construction of the machine may be understood with the greater facility.

It consists of a cask A, whose length is thirty-two, and whose least diameter is eighteen inches. It is divided, by the partition B, into two apartments. The upper and external apartment B A, is in depth fourteen inches. The lower and internal apartment B C, is in depth sixteen inches; and contains a sheet and pipe of copper E E, D, which descend into it nine inches, forming two equal compartments of that depth. The sheet and pipe of copper are soldered together and inserted into the partition B, as may be observed at fig. 2; where B represents the partition, E E the sheet of copper, and D the pipe. The edges E E of the sheet were slid down into corresponding joints in the staves of the cask until the partition attained its proper situation. Coopers' flags were then passed into the joints; and the hoops were driven on the cask.

C F, fig. 1. is a pair of circular bellows. The bottom of the cask serves as a bottom for these bellows. In the centre of this bottom there is a hole, round which, at the distance of one inch from its centre, is a circular rim of wood. On this is nailed a valve opening upwards, which may be observed at B, fig. 3, where there is a transparent engraving of the bellows. Under the valve B may be observed the hole, and circular rim of wood, over which it is nailed. C the top of the bellows, is a circular piece of wood, seven inches in diameter and two in thickness. In its centre there is a hole one inch and a half in diameter. Around this hole there is a circular rabbet, in which is nailed a valve, opening upwards. This valve, and the rabbet in which it is fastened, may be seen under the letter D, at the end of the rod. There is also in this top, at the distance of one inch from its perimeter, a circular dove-tailed furrow filled with lead, E. The body of the bellows F F, is composed of strong hose-leather so as to be water-tight. Before it was fixed to the other parts of the bellows its form was that of a hollow frustum of a cone, of which the perpendicular and greatest diameter were each

each eight inches, and whose least diameter was six inches and a half. It was more easily fastened to its appendages when of this conical form than if it had been cylindrical. At the protuberances FF, it is distended by two iron rings, to which it is sewed fast.

FG, fig. 1, is an iron rod, by means of which the top of the bellows may be raised or depressed. It passes up through the pipe D to the handle G, which is worked by the hand or with the foot by means of the pendent stirrup. An enlarged view of this rod, and of the contrivance by which it is annexed to the top, may be seen at fig. 3; where GD represents the rod, and H, H, H, H, flat pieces of iron branching from it. These are fixed to the circular rim K K in such a manner as to include the rim I I, of the same metal, which is screwed fast to the top of the bellows. Sufficient room is left to allow the pieces H, H, H, H, and the rim K K, to move round without rubbing against the included rim I I, or the top of the bellows.

A copper hood, with an opening in one side, may be observed at L, fig. 3. The rod G D is passed through the centre of this hood, until the flat pieces of iron H, H, H, H, come in contact with the flat part of it. The hole in the centre is then luted. The hood may be seen in its proper situation, at F, fig. 1.

H I, fig. 1, is a suction-pipe half an inch in diameter. It passes under the cask in the direction of the dotted lines at C, and turns up into the hole in the bottom of the bellows. This hole, which is of such a size as to fit the tapering end of the pipe, is seen at fig. 3, and has already been mentioned, together with a circular rim of wood, which, being nailed round it, prevents the end of the pipe from touching the valve. The suction-pipe has a conical mouth at I, into which is inserted occasionally the pipe J, fastened to the hose and syphon K, L. The hose is made of leather, distended by hollow cylinders of tin half an inch in diameter and one inch in length. These were coated with tar, after which the leather was sewed over them *.

Fig. 1, MNO, m n o, are pipes of delivery, furnished with cocks at N, n, and conical mouths at O, o. Each of these pipes communicates with one of the compartments on each side of the sheet and pipe E E, D.

In the partition B, may be observed the pipe Y, furnished

* This hose may be made very perfect by tarring, and covering it with leather a second time; the seams of the first and second coverings being placed on opposite sides. Flexible pipes thus prepared will be found useful for many other purposes besides that here mentioned.

with a cock. Each end of this pipe communicates with one of the compartments above mentioned.

P is a table affixed to the caſk by means of irons, which are at pleaſure ſlid into or out of ſtaples. One of theſe irons, and its ſtaples, may be ſeen near the letter Q. They are faſtened to pieces of wood which run lengthwiſe under the table, and which are ſo grooved as to ſupport a block of wood which ſlides between them. Through this block paſſes the ſcrew S, which ſlides backward and forward in the opening T R V. The ſtand T V, which may be obſerved under the lamp, is looſely put on this ſcrew, as a wheel is placed on its axletree. It riſes and falls with the ſcrew; but is prevented from turning round with it, by the upright ſtrip of wood T.

Having deſcribed the conſtruction of the hydroſtatic blow-pipe, I proceed to an explanation of the principle and manner of its action, and to a detail of the uſes to which it may be applied.

Suppoſe that as much water were poured into the caſk A, fig. 1, as would fill the lower apartment, and riſe above the partition B, one or two inches. Let fig. 4 be a repreſentation of the caſk when ſupplied with this neceſſary quantity of water. When the machine is at reſt, the top of the bellows, being loaded with lead, is depreſſed as low as the folding of the leather will permit, and the ſmall ſpace which remains in conſequence of this folding, between the top of the bellows and the bottom of the caſk, becomes filled with water, which leaks through the upper valve. Let the bellows be extended by depreſſing the handle at *a*. The upper valve will ſhut tight; and a quantity of water equal to the bulk, which the bellows will gain by extenſion, will riſe through the pipe D, to the external apartment; and the weight of the atmoſphere being removed from the top of the valve in the bottom of the caſk, the air will preſs through the ſuction-pipe I H, lift this valve, and occupy the vacant ſpace within the bellows. If the hand be then removed from the handle, the lead in the top of the bellows will again depreſs it, and the air drawn into them, being thereby compreſſed, will force open the upper valve, and aſcend. During its aſcent it will receive a ſtrong lateral tendency from the hood, which will make it paſs out at the open ſide of the hood, into that compartment which is immediately over this opening; and as by turning the rod, this part of the hood may be brought under either compartment, ſo the air may be thrown into either of them; and one of them being filled with one ſpecies of gas, the other may be filled with another ſpecies: nor can there be any danger of mixture; becauſe, as the pipe D is ſhorter than

than the ſheet E E, any ſuperabundant quantity of air which may be thrown into either compartment will paſs up the pipe and eſcape.

In fig. 4, the bellows are repreſented as nearly depreſſed, and the air iſſuing from the open ſide of the hood into the compartment immediately over it, which is about half filled with air. The other compartment is repreſented as being completely full of that fluid. The water is repreſented in commotion, that the action of the machine may be ſtrongly marked; but the motion of this fluid is in reality ſo gentle, that the regularity of a blaſt is not thereby perceptibly affected.

If it be deſired to fill both compartments with one kind of air, without the trouble of turning the hood, by opening the cock of communication in the pipe Y, any air which may be thrown into either compartment will divide itſelf equally between both of them.

It muſt be obvious that the air in the compartments on each ſide of the ſheet and pipe of copper E E, D, fig. 4, is ſubject to hydroſtatic preſſure, and that of courſe it will paſs out at the pipes of delivery, unleſs ſtopt by the cocks. Theſe pipes are omitted in fig. 4, but have been already deſcribed, together with their cocks, at M N O, m n o, fig. 1.

The leather and joints of the bellows are evidently ſubjected to the weight of a conſiderable column of water; but this preſſure, being external, tends to tighten them, and renders this part of the machine ſo perfect, that if the orifice of the ſuction-pipe be cloſed, it will be found impoſſible to raiſe the top of the bellows, without the immenſe force which would be neceſſary to produce a vacuum within them. This would not be the caſe if the ſmalleſt leakage took place.

It is now time to give an account of the purpoſes to which the hydroſtatic blow-pipe may be applied, and the manner of applying it to them.

This inſtrument may be employed to ſupply with atmoſpheric air a ſmall flame for the various purpoſes of the mouth blow-pipe. To effect this, it is only neceſſary to place a lamp or candle on the ſtand T V, which is upheld by the ſcrew S, fig. 1. By raiſing or lowering this ſcrew, or by ſliding backward or forward the block through which it paſſes, the ſtand may be ſo adjuſted, as that the ſtraight mouth-piece X will juſt enter the flame. The handle muſt then be worked until the blaſt obtains the proper ſtrength. This generally happens when the water has riſen above the partition B three or four inches. If it ſhould be raiſed higher,

the blaſt may be regulated by turning the cock more or leſs at N.

When an operation is to be performed on a ſubject which cannot be held over the table; by fixing the ſmall hoſe and blow-pipe a b, fig. 7, into one of the conical mouths O, o, of the pipes of delivery, and, by placing a lamp or candle on the edge of the table, an operator may, with the ſubject in his hand, expoſe the proper ſpot to the flame. In this way glaſs matraſſes filled with liquors have been hermetically ſealed.

Nothing can be more ſteady than the ſtream of air emitted by this inſtrument. The falling off in preſſure, ariſing from the deſcent of the water, does not perceptibly affect the flame in a blaſt of ſix minutes duration; and, in the mean time, the handle may be depreſſed ſo gently, that the moſt ſtrict obſervation will not diſcover the leaſt unſteadineſs to be produced by it. Or, if the machine be filled with air, by opening the cock more or leſs, an equable blaſt may be ſupported for more than the ſpace of an hour.

In order to ſupply the enamellers' lamp with air by means of the hydroſtatic blow-pipe, it is only neceſſary to ſubſtitute this inſtrument for the bellows commonly uſed for this purpoſe. There will then be nothing novel in the manner of operating, excepting, 1ſt, That the relative ſituation of the flame and the pipe is to be regulated by turning the ſcrew S, or by ſliding backward or forward the block through which it paſſes; and, 2dly, That in lieu of the frequent movement of the foot, neceſſary with the common bellows, in the ſpace of one minute, and with fifteen ſtrokes of the handle, as much air may be drawn into the hydroſtatic blow-pipe as will blow for one hour; and as the caſk and pipes are completely air-tight, the blaſt may be ſtopped, or its ſtrength increaſed or diminiſhed at pleaſure, by turning more or leſs the cock of the pipe delivering the air.

The flame of the enamellers' lamp is not uſed excluſively for the purpoſes of the artiſt from whom it takes its name. It is this modification of the principle of the blow-pipe which is applied to the moulding of glaſs inſtruments. But in heating glaſs with this flame, an inconvenience ariſes from the impoſſibility of expoſing both ſides of any ſubject to the ſame heat, unleſs it be conſtantly turned round; for, if only one ſide of a large glaſs tube be applied to the flame, the part expoſed to its action will be fuſed before the other will be ſoftened, and if it be turned round conſtantly a much longer time will be required to melt it. Indeed ſome large tubes of refractory

refractory glaſs, which are not to be melted while undergoing this rotatory motion, may be readily fuſed in any ſpot conſtantly expoſed to the action of the flame.

In order to produce a flame which ſhould be free from the inconveniences juſt deſcribed, I procured the oblong lamp with two wicks W, X, Fig. 1. It may be obſerved, that theſe wicks are fixed on two plates, which ſlide in a groove, in the direction of the length of the lamp. They may therefore be made to approach to, or recede from each other. This lamp being as repreſented in the engraving placed on the little ſtand T V, ſo as that one of the wicks was before the orifice of the ſtraight mouth-piece, above X; the bent blow-pipe at W was ſo adjuſted to the other wick, that when they were both lighted, and a blaſt paſſed over them, their flames met each other as repreſented in the plate. The reſult of this was, that a much larger tube could be fuſed by the united action of two flames, than could be melted with one of them; and the parts being more equally heated, a bend could be made more regularly, and with leſs danger of collapſing.

It may be proper to obſerve that the machine repreſented in the plate is much more complex and expenſive, than is requiſite for the purpoſes of the mouth blow-pipe, or enamellers' lamp, ſimply. But it is expected that artiſts, availing themſelves of the principles of the machine, will reject thoſe appurtenances which are unneceſſary to their peculiar purpoſes *.

[To be continued.]

XXXVII. *Memoir on the Fabrication of Charcoal in the Foreſt de Benon, near Rochelle. Addreſſed to the French Council of Mines, Nivoſe* 30, *Year* 10. *By* C. Fleuriau-Bellevue †.

Fuel of every kind is ſo ſcarce in the neighbourhood of Rochelle, that there are few manufactories in that quarter, and none of thoſe which conſume a large quantity of that article can be eſtabliſhed. Wood is ſold exceedingly dear, and there is ſcarcely a quantity ſufficient for diſtilling the wines of the country.

* The coſt of the machine repreſented in the plate was about twenty dollars; but a machine fully equal to the purpoſes of the mouth blow-pipe, or enamellers' lamp, may be made for one fifth of that ſum.

† From the *Journal des Mines*, No. 65.

It is no doubt to this high price of wood, and the neceſſity of deriving as much advantage as poſſible from the few foreſts in the neighbourhood, that we are indebted for a method of fabricating charcoal which ſeems to be practiſed no where elſe. At any rate, from the ſilence reſpecting it in the *Collection des Arts et des Métiers*, and in *La Nouvelle Encyclopédie*, and from the ſurpriſe expreſſed by ſeveral perſons on ſeeing, in the market of Rochelle, pieces of charcoal of ſuch a ſize and length that they could be tied up and tranſported in the form of faggots, there is reaſon to preſume that it is not known.

The Council of Mines, deſirous to collect every thing that can contribute to the ſucceſs of the different eſtabliſhments of the republic, requeſted me to make known the proceſs. What I have been able to collect on the ſubject is as follows: —

The charcoal of the foreſt of Benon is ſold at Rochelle 25 or 30 per cent. above the price of every other charcoal fabricated from the ſame kind of oak brought from the neighbouring departments. The wood of this foreſt may have ſome ſuperiority over that of others: it grows ſlowly, is hard and heavy; but, as it appears that the ſame means of fabrication are not employed in other places, a ſmall part only of the great difference in the prices of charcoal can be aſcribed to this ſuperiority of the wood.

The care taken to place the furnace in the centre of ſurrounding walls, which, by checking the current of the inferior air, renders the operation of charring more uniform and more perfect, with ſome other circumſtances which will be mentioned hereafter, ſeem to contribute in a ſpecial manner to the advantage in queſtion.

The heaps of wood which are to be converted into charcoal, are everywhere almoſt diſperſed throughout the foreſts, and remain expoſed to the action of the air in every direction; but at Benon the charcoal is fabricated in chambers.

Theſe chambers are 20 feet ſquare: the walls, built of rough ſtones, united by means of earth, are 15 feet in height, and are covered with planks and tiles, arranged in ſuch a manner, that between the planks a ſpace of two inches is left, to afford a free paſſage to the ſmoke.

The floor of the chamber is convex: a maſs of argillaceous earth riſes in the centre about ſix or ſeven inches, having between it and the wall a circular ſpace two feet and a half in breadth, and the four corners free for the ſervice of the furnace.

The only wood employed is oak, known under the name

of black oak, and very rarely white oak *. That cut within the current year is uſed, and never that of the preceding.

The wood is ten, twelve, or fifteen years old, and the lower part of the tree is never ſeparated. It however, in general, does not exceed ſix inches in diameter. It is cut into pieces from three feet eight inches to four feet in length, called *billets*.

They are placed upright, without being ſplit, reſting, with the ſide cut into a ſlope like the mouth of a flute, on the maſs of earth, and in ſuch a manner that they all touch each other; thoſe at the circumference only being a little inclined; and, contrary to the general practice of thoſe who char wood, one ſtory only is formed. Care is taken to mix theſe billets with ſmall branches; but twigs are never introduced, except in the centre of the furnace, merely to kindle it. Two cords of wood are ſometimes employed at one time†.

When the furnace is conſtructed, and is very round, ſtakes, a foot in height, are planted round it, at the diſtance of half a foot: it is then covered with dry graſs, ferns ‡, or *paleines* §, to the thickneſs of four inches in every direction; and over theſe is placed coal earth *(terre de charboniere)* to the ſame height on the ſides, and to the height of 15 inches on the ſummit. In this ſtate, there remains around this focus, called the *furnace*, the circular ſpace before mentioned of about a foot and a half in breadth.

The earth employed is an argil mixed with calcareous earth: it is never removed from this incloſure, where it is baked to ſuch a degree that it might be taken for aſhes, with which it is mixed. It is then called *terre de charboniere*. In other countries, it is known by the name of *frajin* or *frajil*.

Fire is applied in the centre by means of a light placed at the end of a ſtick, introduced by a paſſage formed at the lower part of the furnace. The crevices are ſtopped as ſoon as they appear, and the uſual practice is followed in this reſpect, that the fire may be perfectly regular.

When the wood is charred, half a barrel of water is thrown over it, and then it is covered to the height of five or ſix

* Theſe are varieties of the *quercus robur*. In this ſpecies are diſtinguiſhed the *white*, *red*, and *black*.

† A cord is eight feet in length, four feet in height, and nearly four in breadth.

‡ *Pteris aquilina*.

§ A kind of graſs of the genus *bromus* or *triticum*.

inches with earth: it is then ſuffered to cool for a day, and the charcoal is taken out. This operation laſts eight days in winter, and only four in ſummer. At the latter period the furnace is watched day and night.

The pieces of charcoal extracted are often three inches and more in diameter, and ſufficiently long to be made up into bundles, which are tranſported on the backs of mules to the diſtance of five or ſix leagues: the ſmaller fragments are put into ſacks.

This charcoal, which is very black, exceedingly brilliant, and ſonorous, has two qualities which cauſe it to be much ſought for in preference to all others; it poſſeſſes more activity, and laſts longer. It is attended with the inconvenience of emitting an odour, but it is well known that this is one of the characters of the beſt charcoal.

It is preferred for the kitchen, and for ironing linen. For the latter uſe it is put into iron boxes, called at Rochelle *flaſques*. It is employed alſo by blackſmiths when they have no common coals. That in large pieces is moſt eſteemed.

The latter is ſold at ſeven or eight francs per cwt. delivered at Rochelle; but if the foreſt of Benon were taken proper care of, this price might be diminiſhed *.

This method of making charcoal differs from that deſcribed in the *Collection des Arts et des Metiers*, thoſe of Brie and Burgundy mentioned in the *Encyclopedie*, and thoſe in the departments around Paris.

1ſt. By the incloſure of walls, which muſt ſecure the furnace much better than the hurdles employed in thoſe countries, and which the workman places when he thinks proper on the ſide from which the wind proceeds, this incloſure muſt render the charring more uniform and more economical.

2d. By the care taken not to reſerve for firewood, as is done in ſeveral places, the lower part of the wood, which, being more compact than the branches, ought neceſſarily to furniſh better charcoal.

3d. Becauſe the pieces of wood are longer, and twice as large as thoſe employed in the other methods, and becauſe they are put into the furnace without being ſplit.

4th. Becauſe, inſtead of raiſing, as uſual, four or five ſtories, diſpoſed in the form of a cone or pyramid, one only is

* There are reckoned to be eighteen furnace chambers in the village of Benon, and one at Lalaigne. The foreſt was ſo much deſtroyed during the revolution, that at preſent no more than ſeven or eight chambers are occupied. It ſcarcely ſupplies enough of firewood. No more than 20,000 weight of charcoal is fabricated on it. About thirty or forty years ago it furniſhed ten times as much.

conſtructed,

conſtructed, which renders the action of the current of air much more moderate, and prevents the conſumption of the wood, and perhaps of a part of the hydrogen, which it is eſſentially neceſſary to preſerve in the charcoal.

5th. By the practice followed at Benon of throwing a certain quantity of water over the furnace when the wood is charred. This practice is not mentioned in the works already alluded to.

The foreſts of Chizai and Aunai, which, except that of Benon, are neareſt to Rochelle, furniſh charcoal, which is fabricated alſo from pieces of wood of the ſame ſize, which are put into the furnace in like manner without being ſplit; but the difference in the choice of the wood, and particularly in the fabrication, which takes place in the open air, makes a difference of 25 or 30 per cent. in the price of the charcoal. This difference is ſometimes greater when compared with that of other foreſts.

In the proceſs therefore here deſcribed, there is a ſaving of wood, and at the ſame time the product acquires a greater value.

XXXVIII. *On the Northern Magnetic Pole of the Earth.* By JEROME LALANDE *.

IT has been known for more than two centuries, that the magnetic needle does not point exactly north, and that its declination from that direction is different in different places. Reſearches therefore have been made to determine the point of the earth towards which the magnetic needle turns; and this object engaged the attention of Dr. Halley in 1683, of Euler in 1745, of Lemonnier in 1776, and of Buffon in 1788. About five years ago Mr. Churchman, a native of America, came to Paris to induce government to ſet on foot a voyage to the north pole, for the purpoſe of determining the poſition of the magnetic pole in the north. In the year 1794 he publiſhed a work, in which he propoſes a theory by which the declination of the magnetic needle can be determined for different periods and different places. I endeavoured to compare it with the lateſt obſervations. Thoſe of which I have already ſpoken in the *Connoiſſance des Tems* † were made at Nootka Sound in 48° 36′ north lat. and 129° long. weſt from Paris, in the year 1778; and the declina-

* From *the Connoiſſance des Tems pour l'an.* xii.

† An. iv. p. 215.

tion

tion there was 19° 44′ west. In the supposition that the lines of direction lie in the planes of great circles, and meet in one point, I found it to be in 77° 4′ north lat. Euler in the Memoirs of the Academy of Berlin places it in 75°; Lemonnier, in the *Lois du Magnetisme*, in 73°; and Buffon, in 71°; which makes the differences to be very small. Euler conceived two magnetic poles, which are not diametrically opposite to each other. The two observations which form the ground of my calculation were made, however, near enough to the north pole to enable us to determine it independently of the south pole. Churchman places the north pole in the lat. of 60°; a difference which would be too great.

The two observations here alluded to would give the longitude of the magnetic pole in too doubtful a manner, as the angle at the pole is too obtuse. I endeavoured, therefore, to obtain an intermediate observation, and found that, in the year 1770, at Norreton, in lat. 40° 10′ north, and long. 77° 36′ west from Paris, the declination was 3° 8′ *. From this it would follow, that the longitude of the magnetic pole is 110° 35′ west from Paris. The year, however, of the last observation does not correspond with that of the two former ones: but the difference on this account cannot be of much importance.

At the time of the transit of Venus over the sun's disk in 1779, observed at Hudson's Bay, in lat. 58° 48′ north, and long. 96° 30′ west from Paris, the declination of the magnetic needle was found to be, in that place, 9° 41′ west †. This gave me for the longitude of the magnetic pole only 86° west from Paris. The mean of the two observations, therefore, would be 98°. Euler makes the longitude 115°, and Buffon 100° west from Paris: Lemonnier makes it only 50°. But, as the parallel at so high a northern latitude is only of small extent, a more considerable difference in longitude would have no great influence on the previous determination of the true position of the magnetic pole.

We can therefore admit the given data till a series of more accurate observations of the declination of the magnetic needle, and its variations, collected for different determinate places, shall enable us to deduce from them the variations of the magnetic pole. The variations of the magnetic declination have been observed at Paris for 140 years; but as this has not been the case in America, we still want the proper data for calculating the motion of the magnetic

* American Transactions, p. 117.

† Phil. Transactions 1769, p. 483.

pole:

pole: it seems only to appear that Churchman's hypothesis corresponds very little with the observations which I have calculated, and that the northern magnetic pole lies on the north-west coast of Baffin's Bay, nearly where the entrance of Alderman Jones is to be sought for on Buache's chart of 1782, and where Ferrer Maldonado touched in 1598, according to a Spanish memoir read some years ago in the Academy of Sciences; which, however, seems to deserve very little credit.

XXXIX. *Of the State of Vapour subsisting in the Atmosphere.* By Richard Kirwan, *Esq. F.R.S. and P.R.I.A.*

[Concluded from p. 143.]

THE dilatation of the moisture contained in the air has been separately examined by Mr. Schmidt, and he has shown how from it the volume of air saturated with moisture, saturated, I say, at every degree of Reaumur, may be discovered: the results of his experiments appear in the following table of the volume which 000 measures at 32° of air would acquire if *saturated with moisture* at each degree of Reaumur above 32°, expressed on Fahrenheit's scale *.

Reaum.	Fah.en.	Expansive Force.	Reaum.	Fahren.	Expansive Force.
1°	34·25°	1010·56		70·25°	1122·68
	36·5	1010·78		72·5	1132·25
	38·75	1016·45		74·75	1142·53
	41·	1022·21	20	77·	1152·83
5	43·25	1028·58		79·25	1164·02
	45·5	1034·97		81·5	1175·23
	47·75	1040·41		83·75	1186·52
8	50·	1048·52	24	86·	1198·59
	52·25	1056·26	25	88·25	1211·44
10	54·5	1064·72		90·5	1223·65
	56·75	1071·28		92·75	1279·62
12	59·	1078·52	28	95·	1377·09
	61·25	1087·11		97·25	1494·02
	63·5	1095·76	30	99·5	1610·02
15	65·75	1104·46		101·75	1725·49
16	68·	1113·21	32	104·	1849·96
			33	106·25	1983·42

* To prevent mistakes, it must be noted that this table is not meant to express the dilatations of air saturated at any particular degree of heat it would acquire at other superior degrees, but only the bulk that 1000 parts dry air at 32° would acquire by saturation at each higher degree.

Note.

Note.—1mo. Hence we see that air saturated with moisture at high heats is much more expanded than dry air of the same temperature, as De Luc and general Roy have also observed; but in temperatures below 36·5 dry air is more dilatable; which probably induced Saussure to conclude it was so at higher temperatures. At 54·5 the difference is very perceptible; for 1000 parts *dry* air at 32° are expanded at 54·5°, that is, by 22·5° above the freezing point to 1044·67; whereas 1000 parts of air saturated with moisture are extended to 1064·72, and in higher heats, the differences of expansion are incomparably greater.

2do. Hence it is plain why moist air, such as that of the West Indies, is much more suffocating than dry air of the same temperature: for 1000 cubic inches of air, saturated with moisture at 86° of Fahrenheit, contain nearly 76 inches of moisture which is useless to respiration.

3tio. These experiments agree with those of general Roy in which steam was introduced at hazard; for the general found that from 32° to 52° each degree gave at a mean 2·588, and consequently these 20° would expand 1000 inches to 1051·76; and by Schmidt's experiments, much more accurately made, we have 1050·33.

4to. Schmidt also observed a peculiarity in the expansion of moist air, previously noticed by Roy; for Schmidt found that the expansibility of air, saturated with moisture, was smaller than the expansibility of pure vapour until the 167th degree of Fahrenheit; but in higher degrees they constantly approached nearer to each other. And the general observed that the mean rate of expansion, which from 152° to 172° of Fahr. was 12 for each degree, did, from the 172° to the 192°, increase to 17·88 for each degree, and increased still more after the 192d to the boiling point. The sluggishness of expansion of air, saturated with moisture at about 32°, was also noticed by the general; and he hence concludes the mean rate of expansion from 0 to 32° of Fahr. to be 2·27 for each degree, which is smaller than that of drier air.

These variations of the rates of expansibility of moist air, saturated at different temperatures, Schmidt very justly attributes to the variation of the degrees of affinity or adherence of air and vapour to each other at different temperatures. At 32° Fahr. it is very strong, and also below that degree; and hence the strong solvent power of air colder than the water it acts upon, remarked by Richman: but if both are equally cold, very little moisture will be taken up by the air, as already mentioned: and hence I have said that air dissolves vapour

vapour when this is in a naſcent ſtate. But in heats above 167° or 170° air and vapour are diſpoſed to ſeparate.

5to. Hence we may deduce the impoſſibility of diſcovering a co-efficient univerſally applicable to expreſs the rate of expanſion of air in every ſtate of moiſture, as Tremley has well noticed. (See *Sauſſure Voy. aux Alpes*, ii. 4to.) This muſt vary with the mean ſtate of hygrometers above and below the heights to be meaſured: and experiments of this kind have not yet been made. De Luc's co-efficient anſwers tolerably well for very dry air, that is, whoſe ſaturability is greateſt; ſir George Schuckburgh's, for air much moiſter; and general Roy's, for air ſtill moiſt, that is, whoſe ſaturability is ſmalleſt. Hence each ſucceeds in certain caſes, and fails in others. The dilatation or contraction which air ſaturated with moiſture at any one given degree of temperature receives without the addition of any more moiſture, at any higher or lower degree of temperature, has not as yet been diſcovered: for Schmidt, who alone has attempted it, is juſtly diffident of the correctneſs of the table he has given of it; and, in fact, it is not grounded on the indication of any known hygrometer, and improperly ſuppoſes the 50th degree to indicate the mean betwixt the loweſt and ſaturation: whereas the 65th degree on Sauſſure's indicates that mean; and 98, and not 100, indicates ſaturation.

According to Mr. Watt (as ſtated by De Luc, Meteorology, iii. p. 145), the ſpecific gravity of pure vapour is to that of air as 4 to 9. I ſuppoſe he compares it with air at the uſual denſity of 30 or 29, and at ſome particular temperature which is not mentioned; for at high temperatures the difference muſt be much greater, as appears by the foregoing tables.

M. Sauſſure (Hygrometer, p. 284,) has given us the ſpecific gravity, not indeed of pure vapour, but of vapour diſſolved in air, with more preciſion; for he tells us, 1mo. That a cubic foot of perfectly dry air has its volume augmented by $\frac{1}{54}$th, when ſaturated with ten grains of moiſture at about 65° Fahr. of heat, and barometer 28·77 inches (Engliſh).

2do. That a cubic foot of *pure* or perfectly dry air of that denſity and at that temperature weighs 751 grains (French); and after diſſolving 10 grains of moiſture, by which it is dilated $\frac{1}{54}$th, this new volume weighs $751 + 10 = 761$ grains: but a cubic foot of *pure* air, augmented by an acceſſion of 1-4th of its bulk of pure air, would weigh $751 + \frac{1}{54}751 = 765$ grains, that is 14 grains more. Hence he infers that, in this caſe, the ſpecific gravity of the diſſolved moiſture is to that of dry air as 10 to 14; for $\frac{1}{54}$th of a cubic foot in the one caſe weighs 10 grains, and in the other 14 grains nearly.

But I ſtrongly ſuſpect that the original experiment, on which this calculation is founded, is erroneous, chiefly by reaſon of the ſtrong adherence of moiſture to cold glaſs, as will hereafter be ſeen in treating of dew. From Schmidt's experiments it may be inferred that the ſpecific gravity of vapour, diſſolved in air at this temperature, is much lower with reſpect to that of pure air than Sauſſure has ſtated; for he tells us that about 1066 meaſures of dry air in temperature 65°, would, if ſaturated with moiſture at that temperature, occupy the ſpace of about 1100 meaſures, and conſequently receive an augmentation amounting to about $\frac{1}{3}\frac{1}{3}$d of their bulk: now, transferring this ratio to the cubic foot in Sauſſure's experiment, it appears that $\frac{1}{3}\frac{1}{3}$d of a cubic foot thus added to the cubic foot of dry air weighs 10 grains; but a cubic foot of dry air, augmented by an acceſſion of $\frac{1}{3}\frac{1}{3}$d of ſimilar air, would weigh 751 + 23·46 grains, which approaches nearly to Mr. Watt's ratio: therefore the ſpecific gravity of vapour diſſolved in air at this temperature is to that of perfectly dry air as 10 to 23·5 nearly. It ſhould however be recollected that M. Sauſſure found that a cubic foot of dry air in reality took up 11·069 grains of moiſture when ſaturated at this temperature, and that it was only by way of conceſſion to thoſe againſt whom he argued, that he ſtated the weight taken up at 10 grains; then we ſhould have of 11·069 to 21·195, or, in round numbers, as 11 to 21, or 10 to 19. And it ſhould further be remarked that the temperature is given very looſely, for it is ſtated to be from 14 to 15° or 16° of Reaumur. See Hygrometer, p. 104 and 284.

Sauſſure has given us a table, by the help of which the abſolute quantity of vapour at any barometrical height, in a cubic foot of air, being known, the proportion and abſolute quantity in a cubic foot, at another barometrical height 3·6 inches lower, may be known from the mercurial height 28·77 to that of three inches and one-half nearly.

This table I here give, adapting it to our meaſures.

Barometer	Ratio.
28·77	1·0000
25·17	0·9528
21·57	0·8899
17·97	0·8264
14·37	0·7629
10·77	0·6887
7·17	0·6230
3·57	0·4311

Thus, ſuppoſing the abſolute quantity of diſſolved vapour at any temperature, and barometer 28·77 to be 10 grains per cubic foot; then the quantity of vapour at a height at which a barometer would ſtand at 25·17 inches would be 10 × 0·9528 = 9·528, and at the height at which a barometer would ſtand at ſeven inches, the quantity in a cubic foot would be only 10 × ·6230 = 6·23. But ſtill it is ſuppoſed that at thoſe great heights,

heights, at which barometers would ſtand ſo low, that the air is of the ſame temperature as the original experiment is made at, namely in this caſe, as it is found at barometer 28·77 inches; but ſince in reality air at great heights is generally much colder than below, to aſcertain the real proportion of vapour at thoſe heights it will be neceſſary to find the quantity of vapour which a cubic foot of air is capable of holding at that temperature barometer 28·77, and the ratio which the quantity or weight of vapour actually found, bears to the complement at that temperature. Then, 2do. to find the complement of a cubic foot of air at the temperature which prevails at the given barometrical height, and diminiſh it in the ſame ratio in which it was found diminiſhed below; and finally, diminiſh it ſtill further in the ratio which that barometrical height demands. An example will fully explain this rule.

Thus Sauſſure found, barometer 28·77 and thermometer 82° of Fahr., a cubic foot of air contained about 10 grains of moiſture at Geneva. Now the complement of 82° is nearly 15 grains, and the ratio of 10 to 15 is $\frac{2}{3}$. Then at Mount Blanc, on the ſame hour, the barometer ſtood at 16° and the thermometer at 26·8°: the complement of a cubic foot of air at this temperature is 5·3 grains, which diminiſhed in the ratio of 2 to 3 becomes 3·5; and this, further diminiſhed by the ratio which the barometrical height of 16 inches demands, namely ·78 = 3·5 × ·78 = 2·7 grains, by obſervation it was found to be 1·7: the difference is only one grain. *Voy. aux Alpes*, § 2007. How the temperature which prevails at thoſe great heights may be found, will be ſhown in the ſequel.

The celebrated Lambert of Berlin (Mem. Berlin 1772,) has alſo given an eſtimate of the proportion of vapour which prevails in the atmoſphere at different barometrical heights, deduced from calculations founded on many fictions—ſuch as that of a homogeneous atmoſphere, of pure air diſtinct from common air, and an erroneous ſyſtem of the aſcent of heat; yet, as it is much eaſier in its application, and in the inſtance juſt quoted approaches very near the truth, I have calculated the reſults of his ſyſtem, which is nothing more than that the quantity of vapour at different barometrical heights above the earth is in the ratios of the ſquares of thoſe heights. By a homogeneous atmoſphere it is probable he meant ſuch a ſtate of the atmoſphere as prevails in ſerene unclouded weather; and it is certainly only in ſuch an atmoſphere that any calculation can be inſtituted.

Table

Table of the Ratios of the Quantities of Vapour at different barometrical Heights, the Quantity at the Surface of the Earth being given.

Barometer.	Ratio of Vapour.	Barometer.	Ratio of Vapour	Barometer.	Ratio of Vapour
30·	900	24·	576	12	144
29·5	870	23·	529	11	121
29.	841	22	484	10	100
28·5	812	21	441	9	81
28·	784	20	400	8	64
27·5	756	19	361	7	49
27·	729	18	324	6	36
26·5	702	17	289	5	25
26·	676	16	256	4	16
25·5	650	15	225	3	9
25·	625	14	196	2	4
24·5	600	13	169	1	1

Thus, in the example laſt quoted, the quantity of vapour in a cubic foot at Geneva being 10 grains, barometer 28·77, the quantity on Mount Blanc, barometer 16, ſhould be ·309; for as $827{\cdot}7$ $(= \overline{28{\cdot}77})$ is to 256 $(= \overline{16})$, ſo is 10 to 0·309, which differs from the truth by only 0·391 of a grain.

As vapours unite to air, partly through the agency of heat, and partly through that of affinity and of electricity, ſo they ſeparate from it, ſometimes from a diminution of that degree of heat which they poſſeſſed in their naſcent ſtate, ſometimes from a diminution of affinity, and ſometimes from an alteration in their electrical ſtate.

In their firſt degree of coaleſcence when ſeparated from air, they form aggregates of exceeding minute particles, ſeparated from air by the diminution of affinity, and alſo from each other by electrical atmoſpheres: theſe aggregates are of equal and often lower ſpecific gravity than the air in which they are formed, and yet are viſible by reaſon of their opacity; when near the earth, they are called *fogs*, *miſts*, or *haze*, (which differ only in denſity,) and when at greater heights, *clouds*.

Vapours iſſuing from water or moiſture warmer than the air to which they unite, are ſoon cooled by it, and thence in great meaſure diſmiſſed: hence the morning miſts obſerved in ſummer and the winter miſts of the colder regions: evening miſts, on the contrary, proceed from the ſuperſaturation of air with vapours previouſly diſſolved, ariſing from the ſupervening

pervening decreaſed temperature. The inferior ſtrata of the atmoſphere are ſcarce ever ſuperſaturated by vapours ariſing from water or moiſture warmer than the air into which they aſcend; for, before the point of ſaturation can be attained, their affinity to the portion of air to which they are united is weakened, and thence exceeded by the unincumbered affinity of the ſuperior ſtrata: and this happens ſucceſſively on to the higher regions; but with diminiſhed activity, by reaſon of the diminiſhed denſity of the higher ſtrata, until their ulterior progreſs is checked by ſaturation; but as they are ſtill continually recruited from below, their quantity is at laſt ſo far increaſed that they coaleſce into clouds. Here the proceſs recommences; for from the ſurface of theſe clouds a freſh evaporation often takes place, which, after ſome progreſs, is again checked in its turn, and clouds are formed at a ſuperior height: theſe again give room to a further evaporation, and a new ſtage of clouds is formed, until the proceſs is at laſt arreſted by the intenſe cold of the ſuperior regions. But the mere cold of congelation is not ſufficient to arreſt it; for Bouguer informs us that clouds are formed 2500 feet above the lower line of congelation, and that ice itſelf evaporates, though cooled, ſeveral degrees below the freezing point, is well known. The diſtance of the particles, both of air and vapour, from each other, when ſo far rarefied as they muſt be in the ſuperior regions of the atmoſphere, prevents their coaleſcence in any but the extreme degrees of cold.

Hence we ſee that in the warmer latitudes and ſeaſons various ſtrata of clouds may be formed one above the other: Muſchenbrooek atteſts that even in Holland, in Auguſt 1748, he diſtinctly diſcerned three. Theſe diſtinct ſtrata, variouſly electrified and otherwiſe circumſtanced, give occaſion to various phænomena, the detail of which would here be miſplaced.

The clouds which commonly crown the ſummits even of low mountains, and often announce rain, are cauſed by the near approach to ſaturation at thoſe elevations, and its actual attainment through the evaporation from thoſe ſummits. But the ſummits of the loftieſt mountains ever crowned with ſnow, are generally ſhrowded in clouds, from the cold they impart to the air in contact with them, and the loſs of electricity conducted away from the vapours contained in that air by the mountain.

The heights at which the loweſt clouds are formed, are various in various latitudes and ſeaſons; greater in the warmer, and ſmaller in the colder. In latitude 54° in Cum-

berland, Mr. Croſthwaite obſerved none lower than 2700 feet, and none higher than 3150, in the courſe of ſeveral years *. But this country being mountainous, they are probably lower than in others under the ſame parallel. Lambert, in Berlin, latitude 52° 32′, in the month of July 1773, found their height 7792 feet; thermometer 65°, and the barometer ſomewhat below its mean height †. Schuckburgh alſo remarks that clouds frequently reſt below the ſummit of Saleve, whoſe height is 2831 feet. Phil. Tranſ. 1777, p. 538; and Gentil, at Pondicherry, latitude 12°, obſerved ſome at the height of 10240 feet. ii Voy. p. 79.

The weight of clouds Sauſſure eſtimates at one-third or one-fourth of that of the cubic foot of air in which they ſubſiſt. Hygrometer, p. 270. When the barometer riſes, clouds are partly diſſolved, as denſe air is a better ſolvent than rarer air, and partly riſe higher in conſequence of the increaſed ſpecific gravity of the inferior air; when the barometer falls, the contrary takes place.

XL. *Report, read before the Conference of Mines, on the Specific Gravity of the Coals of ſeveral Mines of France; and on the Difference in the increaſe of Volume which they acquire by Humectation.* *By* C. Blavier, *Engineer* ‡.

THE conference of mines had long been ſenſible of the neceſſity of determining, with rigorous preciſion, the ſpecific gravity of coals in maſſes or in large fragments, in order that it might be compared with that of the ſame article as ſold by the coal merchants. This object was at the ſame time of more importance, as it would make known what difference humectation would produce on the volume which coals occupy in their ſtate of dryneſs.

C. Duhamel and Blavier propoſed to accompliſh this object in the execution of a labour with which they were charged, in order to confirm the different aſſertions already eſtabliſhed by one of them, in a memoir delivered to the conference on the 12th Pluvioſe, year 7.

Theſe commiſſioners wiſhed to take as a fixed and invariable baſe, the *ſolid* coal, or ſuch as it is when extracted from the mine, that they might afterwards proceed progreſſively to that reduced to different degrees of attenuation, and particu-

* D'Alton's Meteorological Obſervations, p. 41.

† Mem. Berlin 1773, p. 44.

‡ From the *Journal des Mines*, No. 65.—We have inſerted this paper as it may furniſh uſeful hints for ſimilar experiments on the varieties of coal in Britain, which are ſo numerous.

larly

larly to thoſe which it experiences till the moment when it paſſes into the hands of the conſumer: but they were obliged to confine their experiments to each of thoſe kinds of coal placed at their diſpoſal by the council, and which were tranſmitted to them directly by the workers of the mines of Creuſſot, St. Etienne, Lataupe, Labarthe, Lacomballe, and Deciſe.

The method by which they were able to aſcertain the ſpecific gravity was as follows:

After bringing the different kinds of coal above mentioned to the uniform ſize of peaſe or beans, by ſifting them, and having carefully picked out all the earthy or ſchiſtous particles, the commiſſioners filled a decalitre with each of them, taking care to chooſe thoſe in the higheſt ſtate of dryneſs, and to pour them in without any ſhock, as merchants do who meaſure them on the ground or in their barges. The weight of each decalitre being aſcertained, the dry coal contained in the veſſel was then watered in ſucceſſion without ſhaking or diſplacing it; and this was continued till the water floated over the ſurface. The coals thus moiſtened were again weighed, and the difference of weight indicated the ſpecific gravity required, ſince this article is impermeable to water, which only fills up the vacuities left between the grains of the bruiſed coal by their uniting under a greater or leſs obtuſe angle.

In regard to the increaſe of weight ariſing from humectation, it will be ſufficient to decant the ſupernatant liquor; and the difference of the two, weighed as above, expreſſed this ſecond reſult.

They then moiſtened ſucceſſively, and in different proportions, each kind of coal; ſuffered the ſuperfluous water to drain off for a quarter of an hour; and, comparing the volume of the dry matter with that which it occupied at different degrees of humectation, were able to diſcover the progreſſive increaſe or diminution by employing for this purpoſe a wire placed exactly level with the ſurface of the veſſel.

The table annexed exhibits the ſeries of the comparative experiments: indicating for each hectolitre of the kinds of coal before mentioned the weight of that article in its ſtate of dryneſs; that of the water introduced, which may be conſidered as ſolid; the increaſe of weight in the moiſtened coals; the augmentation of its volume ariſing from greater or leſs humectation; the number of parts of ſolid coal in a hundred parts of dry coal, and the ſpecific gravity of the latter.

It follows, from the labour of C. Duhamel and Blavier, 1ſt, That the increaſe of weight is always in the direct ratio of the quantity of water added, which itſelf increaſes accord-

ing to the degree of the trituration of the coal, and in the inverſe ratio of the ſpecific gravity of the article. 2d, That the latter alſo is in the inverſe ratio of the weight of the liquid which the dry coal retains after decantation. 3d, That the increaſe of volume is the more ſenſible as a greater quantity of humectation has been produced; and that there exiſts a term at which the addition of water occaſions no change, and beyond which the volume decreaſes in determinate proportions. 4th, In the laſt place, that all theſe reſults vary not only in regard to the different kinds of coal, but even in the ſame kind of coal, according to its nature, its mixture with parts more or leſs earthy, and particularly its ſize or degree of trituration.

The moſt natural concluſion to be deduced from theſe experiments is, that in the ſale of coals there may be introduced abuſes, which it will be of more importance to reform, as in 100 parts of dry coal there are ſcarcely 70 parts of ſolid coal; and beſides, it is proved, that from humectation carried to a certain degree, there may reſult an augmentation or diminution of volume to the loſs of the conſumer or even of the merchant himſelf.

In conſequence of theſe conſiderations, C. Duhamel and C. Blavier, in a report dated Pluvioſe 8, year 10, have concluded that the ſale of coals by weight is attended with the ſame inconveniences as thoſe which take place in a determinate meaſure of capacity. They perſiſt in believing that the combinations of the two methods could not be employed but on the ſuppoſition of coal entirely dry, and yet by expreſſing a wiſh that an accurate table of the ſpecific gravities of all the coals in France, comparing them with each other in different degrees of ſize and humectation, might be drawn out. The reſult would at leaſt be approximative data, by help of which it would be poſſible to expoſe the ſhameful traffic of ſome coal-merchants, who alter the nature of their commodity by mixtures more or leſs earthy. This labour would be particularly important were it accompanied with experiments proper for determining the real value of coal in regard to the uſe for which it is beſt fitted. It is thus, for example, that C. Blavier has already found, by repeated trials, that the *pera* of Deciſe muſt be ſelected to heat reverberating and evaporating furnaces in preference to the ſmall coal of St. Etienne; while the latter, which is ſold in general for at leaſt a fourth more, may be employed with advantage in forges and in all circumſtances where a ſtrong concentrated heat is required. The mixture of theſe two kinds of coal, in the proportion of four to three, gave him an article of fuel the more valuable, as, by furniſhing a more ardent

and

and longer maintained flame, there ariſes to the conſumer a ſaving of more than a fifth, compared with the uſe of either of theſe taken ſeparately. It was with this view that the reporter propoſes to ſubject the different kinds of coals in the republic to experiences, capable of fixing, in an invariable manner, not only their peculiar uſe in commerce and in the arts, but alſo the advantages which would reſult from mixing them in certain proportions.

Table of Experiments on the Specific Gravity of different Kinds of Coal, and on the Increaſe of Weight and Volume which they acquire by Humectation.

Names of the Coals.	Weight of the dry coals per hectolitre. Kilogr.	Weight of the water introduced per hectolitre of dry coal. Kilogr.	Increaſe of weight in the moiſtened coals per hectolitre. Kilogr.	Increaſe of volume of the moiſtened coals per hectolitre. Decalitres.	Number of parts of ſolid coal in 100 parts of dry coal.	Weight of the dry Coal.	
						Per hectolitre. Kilogr.	Per cubic foot. Pounds.
Mine of Labarthe.	88·50	36·10	9·50	1·67	63·9	145·32	97
Mine of Combelle.	86·07	41·53	17·50	2·50	58·5	136·42	95
Mine of Lataupe.	85·50	42·00	19·50	2·50	58·0	135·09	94
Mine of St. Etienne.	84·20	47·10	26·80	1·67	52·9	128·74	90
Mine of Deceiſe.	82·75	50·75	29·95	2·50	49·3	125·55	88
Mine of Creuſot.	79·50	52·75	47·90	2·50	47·25	117·75	85

XLI. *Memoir on the Wax-Tree of Louiſiana and Pennſylvania. By* CHARLES LOUIS CADET, *of the College of Pharmacy* *.

A NUMBER of plants, ſuch as the *Croton ſebiferum*, the *Tomex ſebifera* of Loureiro, the poplar, the alder, the pine, and ſome *labiati*, give by decoction a concrete inflammable matter, ſimilar, in a greater or leſs degree, to tallow or wax; that is to ſay, a fixed oil ſaturated with oxygen. The light down, called the bloom of fruits, and which gives a ſilvery appearance to the ſurface of plums and other ſtone fruits, is wax, as has been proved by M. Prouſt. But the tree which furniſhes this matter in the greateſt abundance, and which in many reſpects deſerves the attention of agriculturiſts, chemiſts, phyſicians, and commercial men, is the *Myrica cerifera*, or wax-tree.

We read in the Hiſtory of the Academy of Sciences for the years 1722 and 1725, that M. Alexandre, a ſurgeon and correſpondent of M. Mairan, obſerved in Louiſiana, a tree of the ſize of the cherry-tree, having the appearance of the myrtle and nearly the ſame odour, and bearing a ſeed of the ſize of coriander. Theſe ſeeds, of an aſh-gray colour, contain a ſmall oſſeous ſtone, pretty round, covered with ſhining wax, which is obtained by boiling the ſeeds in water. This wax is drier and more friable than ours. The inhabitants of the country make tapers of it. M. Alexandre adds: "This ſeed has commonly a beautiful lake colour, and on being bruiſed with the fingers they acquire the ſame tint; but this takes place only at a certain ſeaſon."

The liquor in which the ſeeds have been boiled, and from which the wax has been taken, when evaporated to the conſiſtence of an extract, was found by M. Alexandre to be an effectual remedy for checking the moſt obſtinate dyſenteries.

The advantageous properties exhibited by this tree could not but induce ſcientific men to make reſearches for the purpoſe of aſcertaining the varieties of this vegetable production, and what care was required in its culture. It was long conſidered as a mere object of curioſity.

Linnæus, in his Vegetable Syſtem, ſpeaks only of the wax-tree of Virginia (*Myrica cerifera*), with leaves lanceolated as if indented, ſtem arboreſcent.

Having requeſted C. Ventenat to inform me how many ſpecies there are of it, he replied that Ayton has diſtinguiſhed two, viz.

* From the *Annales de Chimie*, No. 131.

1ſt, *Myrica*

1ſt, *Myrica cerifera anguſtifolia*, which grows in Louiſiana. This tree is delicate, flowers with difficulty in our green-houſes: its ſeeds are ſmaller than thoſe of the following.

2d, *Myrica cerifera latifolia*, which grows in Pennſylvania, Carolina, and Virginia. It does not riſe to ſuch a height as the former, and is perfectly naturalized in France. Theſe two *Myricæ* are of the family of the *dioici*.

They are both cultivated at the *Muſeum des Plantes* and in the gardens of C. Cels and Lemonier.

C. Michault admits a third ſpecies of *Myrica cerifera*, which he calls the dwarf wax-tree. C. Ventenat thinks that wax may be extracted from all the *Myricæ*.

The authors who have ſpoken of theſe trees with ſome details are C. Marchal, tranſlated by Leſerme, Lepage-Duprat, and Toſcan, librarian of the Muſeum of Natural Hiſtory. A memoir inſerted by the latter in his work intitled *L'Ami de la Nature*, makes known the manner in which vegetable wax is collected in the colonies.

"Towards the end of Autumn," ſays he, "when the berries are ripe, a man quits his home, with his family, to proceed to ſome iſland, or ſome bank near the ſea, where the wax-trees grow in abundance. He carries with him veſſels for boiling the berries, and an axe to build a hut to ſhelter him during his reſidence in that place, which is generally three or four weeks. While he is cutting down the trees and conſtructing the hut, his children collect the berries: a fruitful ſhrub can furniſh about ſeven pounds. When the berries are collected, the whole family employ themſelves in extracting the wax. A certain quantity of the ſeeds are thrown into the kettles, and water is poured over them in ſufficient quantity to riſe to the height of half a foot above them. The whole is then boiled, ſtirring the ſeeds from time to time and preſſing them againſt the ſides of the veſſels, that the wax may more eaſily be detached. A little after, the wax is ſeen floating in the form of fat, which is collected with a ſpoon and ſtrained through a piece of coarſe cloth to ſeparate the impurities mixed with it. When no more wax detaches itſelf, the berries are taken out by means of a ſkimmer, and new ones are put into the water; taking care to renew it the ſecond or third time, and even to add more *boiling* water in proportion as it is conſumed, that the operation may not be retarded. When a certain quantity of wax has been collected in this manner, it is placed on a piece of linen cloth to drain, and to ſeparate the water with which it is ſtill mixed. It is then dried, and melted a ſecond time

for the purpose of purifying it, and is moulded into the form of cakes. Four pounds of the seeds give about a pound of wax. That which detaches itself first, is generally yellow, but in the last boilings it assumes a green colour, in consequence of the tint communicated to it by the pellicle with which the nucleus of the seed is covered."

Kalm, the traveller, speaking of the vegetable wax, says that in countries where the wax-tree grows, it is employed for making excellent soap, with which linen can be perfectly washed.

Such was the knowledge naturalists had of the myrica, or at least no other observations, as far as I know, had been published, respecting it, when a naturalist gave me half a kilogramme of the vegetable wax of Louisiana. I was desirous to analyse it, and compare it with the wax made by our bees, but before I undertook this labour, I wished to be acquainted with the nature of the shrub, and of the seeds of the myrica. I saw this valuable production in the *Jardin des Plantes*, and wrote to C. Deshayes, a zealous botanist, who superintends at Rambouillet the cultivation of the *Myrica pennsylvanica*, to beg he would give me a few details on that subject. He was so kind as to return an answer, accompanied with some of the seeds, which I took the earliest opportunity of examining.

This seed is a kind of berry, of the size of a pepper-corn; its surface, when it is ripe and fresh is white, interspersed with small black asperities, which give it the appearance of shagreen. When rubbed between the hands, it renders them unctuous and greasy.

If one of these small berries be strongly pressed, it divests itself of a matter in appearance amylaceous, mixed with smal round grains like gunpowder. The nucleus, which remains bare, has a very thick ligneous covering, and contains a dicotyledon kernel. By rubbing a handful of the berries on a hair sieve, I obtained a gray dust, in which I could distinguish, by the help of a magnifying glass, the small brown grains already mentioned, in the middle of a white powder.

I put this powder into alcohol, which by the help of a gentle heat, dissolved all the white part, and left the black powder, which I collected a-part. Water poured over this alcoholic solution, disengaged a substance which floated on the surface of the liquid. I melted this substance, and obtained a yellow wax, similar to that brought me from Louisiana. This experiment was sufficient to prove that the wax of the myrica is the white rough matter which envelopes the seeds.

The black powder which I separated appeared to me to contain

contain a colouring principle, and I did not deſpair that I ſhould find in it the beautiful lake, mentioned by M. Alexandre. With this view, I bruiſed ſtrongly the powder, and boiled it in a ſolution of acid ſulphate of alumine. I was much aſtoniſhed to obtain nothing but a liquor ſcarcely coloured, and the alumine precipitated by an alkali, was only ſlightly ſtained.

I took another part of this black bruiſed powder, and put it to infuſe in alcohol. I ſoon obtained a tincture of the colour of wine lees: on heating this tincture, it became as red as a ſtrong tincture of cinchona or cachou. This reſult induced me to believe that the colouring principle was reſinous, but by adding water I ſaw no precipitate formed.

I poured into this tincture water charged with ſulphate of alumine; a ſlight precipitate was produced: a ſolution of ſulphate of iron formed it immediately into an ink.

What is the aſtringent colouring principle which is not ſoluble in alcohol, which forms no precipitate with water, and which has ſo little attraction for alumine? To find it a ſeries of experiments, which the few ſubſtances I had in my poſſeſſion did not permit me to make, would have been neceſſary. The aſtringent matter mentioned by M. Alexandre, muſt be found in the decoction of the unbruiſed ſeeds. To aſcertain this fact, I boiled the ſeeds in a ſilver veſſel. The decoction on which a little wax floated, was of a greeniſh colour, with a taſte ſomewhat ſtyptic: it precipitated ferruginous ſolutions black. Having heated it in a very clean iron veſſel, it ſpeedily became black. To know whether this property aroſe from the gallic acid alone, or from tannin, I mixed a little of the concentrated decoction with a ſolution of gelatin, but no precipitate was formed.

It is therefore to the pretty conſiderable quantity of gallic acid contained in the ſeeds of the myrica, that the virtue of its extract in checking dyſentaries ought to be aſcribed. In this reſpect, I am of opinion that the leaves and bark of the tree would furniſh an extract ſtill more aſtringent than the berries.

The following are the moſt intereſting reſults of an examination of the wax:

When extracted either by decoction from the ſeeds, or by ſolution of the white powder in alcohol precipitated by water, this melted wax is always of a yellow colour, inclining to green. Its conſiſtence is ſtronger than that of the wax made by bees; it is dry and friable enough to be reduced to powder; in a word, it is manifeſtly more oxygenated than wax prepared by theſe inſects. Tapers made with the wax of the

myrica give a white flame and a beautiful light, without ſmoke, do not run, and when new emit a balſamic odour which the inhabitants of Louiſiana conſider as very beneficial to the ſick: when diſtilled in a retort, it paſſes in a great part to the ſtate of butter. This portion is whiter than it was before, but it loſes its conſiſtence, and acquires that of tallow. Another portion is decompoſed, furniſhes a little water, ſebacic acid, and empyreumatic oil. A great deal of carbonated hydrogen gas and carbonic acid gas are diſengaged, and there remains in the retort a black carbonaceous bitumen. Common wax when diſtilled, exhibits the ſame phænomena.

I have already ſaid that alcohol diſſolves the wax of the myrica, but ether diſſolves it much better, and, by the evaporation of the liquid, it ſeparates in the form of ſtalagmites. Neither of theſe liquids deſtroy its colour. If this wax be boiled with dilute ſulphuric acid, it becomes a little whiter, but there is no ſenſible combination of the acid with it. The yellow wax of bees, treated in the ſame manner, did not change its colour.

Oxygenated muriatic acid bleaches both kinds of wax perfectly. The vegetable wax, however, loſes its colour with more difficulty.

The vegetable wax diſſolves in ammonia. The ſolution aſſumes a brown colour: a part of the wax becomes ſaponaceous. The volatile alkali has much leſs action on the wax of bees.

Theſe two kinds of wax, when ſtrongly agitated in a boiling ſolution of cauſtic potaſh, waſh and form a real ſoap, as obſerved by Kalm the traveller. The whiteneſs which wax acquires by this ſaponification is not a new phænomenon. C. Chaptal, in his proceſs for bleaching by the ſteam of alkaline lees, has proved that the colouring principle of vegetables yields to the action of alkalies. Some chemiſts aſcribe this effect to the direct combination of ſoda or potaſh with the coloured extractive part, and a combination which brings it to a ſtate almoſt ſaponaceous and renders it ſoluble.

According to my opinion, the alkali, in this operation, exerciſes over the oil or wax a double attraction, firſt direct with the conſtituent principles of the oil, then prediſpoſing and favouring the combination of the oxygen of the atmoſphere with oil or wax. I do not know whether any one before me ever entertained this idea; but it was ſuggeſted by obſerving what takes place when ſoap is decompoſed by an acid. The oil is always concrete and more oxygenated than it was before.

It

It would be of importance for the theory of chemiſtry to make ſoap, if poſſible, in a cloſe veſſel, and to examine the air afterwards, or in different gaſes containing no oxygen.

By decompoſing ſoap of the myrica, very white wax is obtained; but in a particular ſtate, which does not admit of its being employed for our purpoſes.

Litharge, or ſemi-vitreous oxide of lead, diſſolves very well in the melted wax of Louiſiana. It forms a very hard maſs, the conſiſtence of which may be diminiſhed at pleaſure by the addition of a little oil. If the wax of the myrica, as there is reaſon to think, retains a portion of the aſtringent principle given by a decoction of the berries, the phyſicians, perhaps, will find uſeful properties in topics made with this wax.

By taking a general view of what has been here ſaid, it is ſeen that the myrica may be of very great ſervice in the arts. The wax which it furniſhes is ſufficiently abundant to prove an ample indemnification for the care and expenſe of cultivation, ſince a ſhrub in full bearing gives ſix or ſeven pounds of berries, from which a fourth of wax may be extracted. This wax is of a quality ſuperior to that of bees.

The aſtringent principle of the myrica, extracted on a large ſcale, may be very uſeful either in medicine or in the arts. In certain reſpects it may be ſubſtituted for the gall-nut in dyeing, hat-making, and perhaps in the tanning ſome kinds of leather. The colouring principle ſeems to be ſufficiently fixed to deſerve ſome attention; and, if it be true that in Louiſiana beautiful lakes are made from it, why is it not rendered uſeful in painting?

In a word, when this wax becomes ſufficiently common to be ſold at a low price, great advantage might be derived from it in making ſoap.

The art of bleaching this wax requires alſo ſome reſearches, when it is to be performed on a large ſcale with œconomy. Two re-agents preſent themſelves to manufacturers—the ſulphuric acid and the oxygenated muriatic. But as wax does not ſink in theſe liquids, means muſt be found to multiply the contact, either by cutting the wax into ſlices and beſprinkling it with oxygenated muriatic acid, or ſhutting it up when cut in this manner, in caſks, into which oxygenated muriatic acid is introduced.

I ſhall propoſe a third method, which ſeems to promiſe a ſpeedier effect. Place the wax, cut into ſmall pieces, in alternate ſtrata with hyper-oxygenated muriate of lime: when arranged in this manner, leave it for ſome time dry and in contact. The ſalt and acidulous water are then to be decompoſed by the

the fulphuric acid, taking care to pour in water gradually, at different periods, till there is no longer a fenſible diſengagement of muriatic gas. A large quantity of water is then to be added, and the mixture muſt be ſtirred with a rod. By reſt, the inſoluble ſulphate of lime is precipitated, and the bleached wax will float at the ſurface.

I ſhall terminate this memoir with ſome obſervations on the culture of the myrica.

C. Deſhayes, to whom I am indebted for the trials I made, has obſerved, for ſeveral years, the wax-trees of Rambouillet. What he wrote to me on this ſubject is as follows:

"The *Myrica latifolia* (Ayton) is here abſolutely in its native country: it is in the ſoil proper for it; that is to ſay, in ſandy and blackiſh turf. We have ſixteen wax-trees in full vigour. They are four, five, and ſix feet in height: one male is ſeven feet. The ſeeds are abundant almoſt every year: I ſay almoſt, becauſe in ſome years they fail. The fruit in general is in that part of the Engliſh garden aſſigned to it.

"The culture requires no care. Every year a great number of ſhoots, which proceed from the roots of the large trees, are pulled up. Theſe are ſo many new ſhrubs, which are then planted at the diſtance of a yard from each other.

"The ſeeds may be ſown in beds in the ſpring, and then tranſplanted: but this method is tedious. The myrica will ſucceed wherever it finds a light ſoil, ſomewhat moiſt. How many provinces are there where the cultivation of this ſhrub would be uſeful, and employ land almoſt neglected!

"What advantages may not agriculture hope for from ſuch an acquiſition, ſince Pruſſia has ſo long ſeen the myrica flouriſh in its dry, ſandy plains!"

C. Thiebault, of the Academy of Berlin, gave me the following intereſting note on this ſubject:

"The late M. Sulzer, author of a general dictionary of the fine arts, had obtained from Frederic the Great a pretty extenſive piece of waſte land on the banks of the Spree, at the diſtance of half a league from Berlin, in a place called the Moabites. However barren this ground, which preſented only a very thin, poor turf, above fine light ſand, might be, M. Sulzer converted it into a very agreeable garden, worthy of a philoſopher. Among other remarkable things he formed a plantation of foreign trees, conſiſting of five pretty long alleys running eaſt and weſt. In theſe alleys there were not two trees of the ſame kind following each other. In the alleys moſt expoſed to the north he planted none but the higheſt trees, capable of withſtanding the ſeverity of the climate.

Hence,

Hence, in proceeding from the north to the ſouth, the firſt alley exhibited trees of about ſeventy feet in height, the ſecond trees of from twenty-five to thirty, and ſo on, in the form of an amphitheatre; ſo that all theſe trees had the ſun at leaſt in part, and the weaker were ſheltered by the ſtronger.

"In the moſt ſouthern alley I obſerved a ſort of ſhrub which roſe only to the height of two or three feet, and which M. Sulzer called the wax-tree. Every perſon viſited this alley in preference to the reſt, on account of the delicious perfume emitted by the leaves, which they retained a very long time.

C. Thiebault then ſpeaks of the method of extracting the wax. This operation is the ſame as that deſcribed by M. Alexandre.

"I have ſeen," adds he, "one taper of this wax perfume three chambers which compoſed M. Sulzer's private apartments, not only during the time it was lighted, but even for the reſt of the evening."

The myrica cultivated at Berlin was, no doubt, more odoriferous than that which we poſſeſs, the wax of which does not emit the ſame perfume.

M. Sulzer intended to make tapers of this wax not bleached, covered with a coating of our fineſt wax. The heirs of this academician ſold the garden, but the wax-trees ſtill remain. They were planted in 1770.

If it has been found poſſible to naturalize the *myrica cerifera* in the north, why ſhould we neglect a vegetable production ſo valuable, which would certainly thrive in our ſouthern departments, and which requires leſs care than bee-hives. The ſucceſsful trials which have been made muſt excite the zeal of our agriculturiſts.

The government has already encouraged this branch of induſtry by ordering plantations of the wax-tree. There are nurſeries at Orleans and Rambouillet which contain more than 400 ſhrubs. Reſults ſo ſatisfactory cannot be made too public. Uſeful plants are always propagated ſlowly: a barren but picturesque tree, an agreeable ſhrub, are ſoon adopted through faſhion: they ornament the parterres of our modern Luculluses and the flower-pots of our Phrynes, while our indefatigable agriculturiſts exhauſt themſelves in vain efforts to enrich our meadows with a new graſs, or to fill our granaries with a new nouriſhing grain. The vulgar, through prejudice, long rejected maiz and potatoes, which have been of ſo much ſervice to our ſoldiers and to the poor. The oak, which fed our anceſtors, is no longer found in our foreſts. Let us, however, hope that our agriculturiſts will

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at length open their eyes to their real intereſts; and that, laying aſide their old prejudices, they will not diſdain the preſents which learned ſocieties are deſirous to give them, and which will conduce as much to their advantage as to the glory and proſperity of France.

XLII. *Proceedings of Learned Societies.*

ROYAL SOCIETY OF LONDON.

ON the 30th of November, being St. Andrew's day, the Royal Society held their anniverſary meeting at their apartments in Somerſet-place, when the gold medal (called Sir Godfrey Copley's) was preſented to William Hyde Wollaſton, M.D. for his various papers printed in the Philoſophical Tranſactions.

Afterwards the Society proceeded to the choice of the council and officers for the enſuing year, when, on examining the ballots, it appeared that the following gentlemen were elected of the council:

Of the old council—The right hon. ſir Joſeph Banks, bart. K.B.; ſir Charles Blagden, knt.; Henry Cavendiſh, eſq.; Edward Whitaker Gray, M.D.; right hon. Charles Greville; right hon. ſir William Hamilton, K.B.; Rev. Nevil Maſkelyne, D.D.; George earl of Morton, K.T.; Joſeph Planta, eſq.; Benjamin count Rumford; Samuel Wegg, eſq.

Of the new council—Mark Beaufoy, eſq.; Andrew Douglas, eſq.; ſir Martin Browne Folkes, bart.; Charles Hatchett, eſq.; Everard Home, eſq.; Thomas Barnard, lord biſhop of Limerick; William Marſden, eſq.; Joſeph de Mendoza Rios, eſq.; Francis earl of Moira; William Hyde Wollaſton, M.D.

And the officers were—Sir Joſeph Banks, bart. preſident; William Marſden, eſq. treaſurer; Joſeph Planta, eſq., Edward Whitaker Gray, M.D., ſecretaries.

Afterwards the members of the Society dined together, as uſual, at the Crown and Anchor tavern, in the Strand.

The Tranſactions of the Society for 1802 contain the following papers:

1. The Croonian Lecture. On the Power of the Eye to adjuſt itſelf to different Diſtances, when deprived of the Cryſtalline Lens. By Everard Home, Eſq. F. R. S.—2. The Bakerian Lecture. On the Theory of Light and Colours. By Thomas Young, M. D. F. R. S. Profeſſor of Natural Philoſophy in the Royal Inſtitution.—3. An Analyſis of a

mineral Subſtance from North America, containing a Metal hitherto unknown. By Charles Hatchett, Eſq. F. R. S.—4. A Deſcription of the Anatomy of the Ornithorhynchus paradoxus. By Everard Home, Eſq. F. R. S.—5. On the Independence of the analytical and geometrical Methods of Inveſtigation; and on the Advantages to be derived from their Separation. By Robert Woodhouſe, A. M. Fellow of Caius College, Cambridge.—6. Obſervations and Experiments upon oxygenized and hyper-oxygenized muriatic Acid; and upon ſome Combinations of the muriatic Acid in its three States. By Richard Chenevix, Eſq. F. R. S. and M. R. I. A.—7. Experiments and Obſervations on certain ſtony and metalline Subſtances, which at different Times are ſaid to have fallen on the Earth; alſo on various Kinds of native Iron. By Edward Howard, Eſq. F. R. S.—8. Obſervations on the two lately diſcovered celeſtial Bodies. By William Herſchel, L. L. D. F. R. S.—9. Deſcription of the Corundum Stone, and its Varieties, commonly known by the Names of Oriental Ruby, Sapphire, &c.; with Obſervations on ſome other mineral Subſtances. By the Count de Bournon, F. R. S.—10. Analyſis of Corundum, and of ſome of the Subſtances which accompany it; with Obſervations on the Affinities which the Earths have been ſuppoſed to have for each other, in the humid Way. By Richard Chenevix, Eſq. F. R. S. and M. R. I. A.—11. Deſcription of the Anatomy of the Ornithorhynchus Hyſtrix. By Everard Home, Eſq. F. R. S.—12. A Method of examining refractive and diſperſive Powers, by priſmatic Reflection. By William Hyde Wollaſton, M. D. F. R. S.—13. On the oblique Refraction of Iceland Cryſtal. By William Hyde Wollaſton, M. D. F. R. S.—14. An Account of ſome Caſes of the Production of Colours, not hitherto deſcribed. By Thomas Young, M. D. F. R. S. F. L. S. Profeſſor of Natural Philoſophy in the Royal Inſtitution.—15. On the Compoſition of Emery. By Smithſon Tennant, Eſq. F. R. S.—16. Quelques Remarques ſur la Chaleur, et ſur l'Action des Corps qui l'interceptent. Par P. Prevoſt, Profeſſeur de Philoſophie à Genève, &c.—17. Of the Rectification of the Conic Sections. By the Rev. John Hellins, B. D. F. R. S. and Vicar of Potter's Pury, in Northamptonſhire.—18. Catalogue of 500 new Nebulæ, nebulous Stars, planetary Nebulæ, and Cluſters of Stars; with Remarks on the Conſtruction of the Heavens. By William Herſchel, LL. D. F. R. S.

APPENDIX.—Meteorological Journal kept at the Apartments of the Royal Society, by Order of the Preſident and Council.

FRENCH

FRENCH NATIONAL INSTITUTE.

Proceedings during the laſt quarter of the year 10, continued from our laſt Number.

NATURAL PHILOSOPHY.

Of Meteors ſuppoſed to fall under the form of Stones.

A great deal has been ſaid of ſtones which have fallen from the clouds; it was long believed that this was one of the forms aſſumed by thunder in its fall; they were then conſidered as the product of the exploſion of certain luminous balls, which are ſometimes obſerved. The rarety of theſe phænomena, however, which has not allowed of their being ſeen at a ſhort diſtance by obſervers poſſeſſed of intelligence, and at the ſame time worthy of credit, and which ſeems hitherto to have reſerved them for the eyes of the vulgar, ſo much inclined to exaggeration, has prevented the learned from believing in the exiſtence of theſe ſtones.

However, moſt mineralogical collections, contain a great number of ſtones, to which this origin has been aſcribed. They exhibit exterior uniform characters: a ſpecific gravity nearly equal, and by analyſis, give the ſame component parts, among which is nickel, a ſubſtance rarely found at the ſurface of the earth; and iron in a metallic ſtate, which is never met with in volcanic productions, to which theſe ſtones in other reſpects ſeem to be very analogous.

Theſe remarks have induced Mr. Howard, and Count de Bournon, to think that, however doubtful the fall of ſtones from the atmoſpheric regions may be, it ought to be ſubjected to accurate examination. They have collected the different teſtimonies in a paper read before the Royal Society of London, and C. Pictet thought it proper to preſent it to the claſs, that the attention of philoſophers may be directed to this ſubject, in order that the phænomenon, if true, may be confirmed; or, if only an illuſion ſupported by popular error, may be confined for ever to the claſs of errors.

CHEMISTRY.

On the Pruſſiates of Barytes and Lime.

After the baſes of a theory have been eſtabliſhed on important facts well confirmed, and when by a methodical arrangement of the ſcience they have been diſtributed, as we may ſay, into regions, the communications between which are known, it remains to review them in detail, in order that all

all the parts may be carefully described, and that these parts may be assigned to the regions which they compose. Such, it appears is the idea which may be formed of the present state of the chemical knowledge of salts. Their general formation seems to be well known, the great divisions are well established, and the principal facts have been exactly observed and classed; but notwithstanding these satisfactory labours, many details are still unknown or imperfect. Hence the researches of the chemists of the institute during this quarter have been particularly directed towards this object, and it will be seen that they have not been fruitless.

The liquor charged with the colouring matter of Prussian blue, having manifested the property of taking metals from their solvents, without producing a decomposition of the salts with an alkaline or earthy base, the phænomenon of the precipitation of barytes had been considered as an indication of the metallic nature of that substance, which could not be reduced to a metallic state, because it had a greater affinity for oxygen than carbon. The most celebrated chemists had adopted this opinion, others had announced that precipitation did not take place. Mr. William Henry thus maintaining that prussiates perfectly purified did not produce any precipitation, confirmed himself the first observations of Bergman and Lavoisier, and announced that there was formed by double affinity a real prussiate of barytes. C. Guyton, having long observed that prussiate of lime was decomposed by carbonate of potash, made use of this experiment, and those of Mr. Henry, to fix the theory of these phænomena; and, instead of concluding, like the English chemist, that barytes differs in this respect from other earths, and approaches the nature of metals, he shows that the same effect takes place with lime, strontian, magnesia, potash, soda, and even ammonia, and consequently that, in all these cases, there is nothing but the necessary result of the concurrence of several divellent forces.

On Mercurial Salts.

After treating different oxides of mercury, as already mentioned in his memoir, C. Fourcroy continued to read an account of his labour during the last quarter. In this second part he employed himself on the sulphates and nitrates of mercury; a very complex kind of compounds, exceedingly variable, the characters and properties of which have been examined by many chemists, without their being able to determine the real differences between them, and particularly the cause of these differences. The author had already made

this kind of combination the ſubject of his reſearches, and in 1791 communicated to the academy of ſciences a pretty long paper on theſe ſalts. He eſtabliſhed three kinds of them, diſtinguiſhed by the proportions of acid and oxide, and he ſhowed a difference between them, founded on the different ſtates of oxidation of the metal.

Different ſulphates are made not only by expoſing mercury with ſulphuric acid to a greater or leſs heat, and for a longer or ſhorter time, but alſo by mixing this acid or a ſoluble ſulphate with a nitric ſolution of mercury, more or leſs oxidated. If the latter is little oxidated, a white precipitate of ſulphate little oxidated is obtained; if it be much oxidated a yellow precipitate highly oxidated will be obtained; ſulphuric acid united to two or three parts of water does not form ſulphate of mercury much oxidated, unleſs it be concentrated by long and ſtrong ebullition; without this, the water added for waſhing does not render the mixture yellow, and will not make turbith mineral. The author gives the proportions of the component parts, acid, oxygen and mercury, of the different neutral or acid ſulphates, little or very much oxidated. Theſe reſults are a ſupplement to his labour of 1791 on this kind of mercurial ſalts.

Nitrates of mercury furniſhed him with obſervations ſtill newer and more important for ſcience than the ſulphates. There are two kinds of nitrates, one much oxidated, and the other little oxidated. The former is precipitated, of a gray colour, and almoſt black by alkalies, and white by ſulphates; with muriatic acid it forms mercurius dulcis. The nitrate much oxidated, reſults from long and ſtrong ebullition, gives no precipitate by muriatic acid, it gives a yellow one with ſulphates, a white one with ammonia, and an orange yellow one with fixed alkalies. Nitric ſolutions of mercury, are often mixtures of the two ſalts. That which precipitates by water is a ſolution of oxide much oxidated, or red, in concentrated acid. When a nitric ſolution of mercury, little oxidated, is precipitated by a fixed alkali, the firſt portion of the white precipitate, a little coloured, which is obtained, is a nitrate of mercury inſoluble and neutral, formed by the union of the ſeparated portion of oxide with the remainder of the ſolution which is not decompoſed. What is new in this labour is, the compariſon of the properties of the nitrite of mercury with thoſe of the nitrate. Almoſt all ſolutions contain more or leſs of the former of theſe ſalts. It is prepared by making nitrous gas paſs into nitric ſolutions, which greedily abſorb it. Super-oxidated nitrate abſorbs much more of it than the nitrate little oxidated. The latter, nitrite of mercury,

cury, disengages a great deal of rutilating vapour by the sulphuric and nitric acids. It tinges the skin of a dark purple colour: while nitrate very much oxidated dyes it black, and nitrate little oxidated, like the nitrite of the same nature, does not change the colour of animal matters. It retains longer in the open air its nature of nitrite than the alkaline nitrites, which speedily resume the nature of nitrates. Alkaline nitrites, and particularly deliquescent nitrites, may be prepared without difficulty by impregnating the solutions of nitrates, &c. with nitrous gas, which easily condenses in them.

The author, to terminate his labour, is to occupy himself with the muriates of mercury, of which he has discovered a new kind, and with the sulphurets of the same metal. It would be a pity that the important and numerous functions entrusted to him, should oblige him to discontinue these useful researches; but, happily for the interest of science, people seldom abandon a career which they have long pursued with success.

On Aluminous Sulphates.

S. Seguin, having been employed in continued researches on the different states of the sulphates of alumine, read on that subject a memoir, in which he proves That the acid sulphate of alumine pure, that is to say when free from those substances which it is necessary to add to it in order to make it crystallize, does not, in any case, decompose the muriate of soda—That alum, the cause of the crystallization of which is the sulphate of potash, does not experience decomposition from the muriate—That alum, the cause of the crystallization of which is the sulphate of ammonia, receives no alteration from the muriate of soda, when it contains only the quantity of sulphate of ammonia indispensably necessary for its crystallization—Finally, that alum, containing more sulphate of ammonia than the quantity necessary for its crystallization, is the only salt which experiences alteration by the muriate of soda; and that this alteration is confined merely to the decomposition of the sulphate of ammonia which it contains in excess.

A New Triple Salt.

There results from the decomposition above mentioned, on the one hand muriate of ammonia, and, on the other, a triple salt, composed of sulphuric acid, soda and ammonia, and which had not been before remarked.

A mixture either of the sulphate of ammonia and muriate of soda, or of sulphate of soda and sulphate of ammonia,

produces this triple ſalt in its full purity. In the firſt of theſe two caſes, the affinity of the ſulphate of ammonia for the ſulphate of ſoda oppoſes the total and generally admitted decompoſition of the ſulphate of ammonia by the muriate of ſoda. This triple ſalt acts a diſtinguiſhed part in the fabrication of ſal ammoniac: it cryſtallizes regularly; does not effloreſce in the air; has a ſavour, at firſt pungent, then ſlightly bitter; is decompoſed by ſoda, which transforms it wholly into ſulphate of ſoda; decrepitates in the fire, ſwells up in it, and ſuffers to be diſengaged, firſt ammonia, and then acid ſulphate of ammonia, while pure ſulphate of ſoda remains at the bottom of the veſſel.

A New Poliſhing Rouge.

Chemiſtry, which can contribute in ſo effectual a manner to the improvement of the arts, does not loſe this important direction, and, in this reſpect, deſcends to the minuteſt details. In conſequence of a report preſented to the Claſs, on a *rouge* for poliſhing, C. Guyton communicated ſome obſervations on ochry reds ſimilar to thoſe of Almagra in Spain, and which, in many caſes, might be ſubſtituted for red oxide of iron or colcothar. He mentioned as a very œconomical proceſs, and proper for giving the laſt poliſh to the hardeſt matters, the uſe of bits of old hat, which, as is well known, are dyed with iron. By immerſing theſe pieces of hat for ſome minutes in ſulphuric acid, the iron which they contain paſſes to the ſtate of red oxide, and they then become excellent pieces for poliſhing, and may be uſed in the ſtead of the fineſt rouge.

Analyſis of an Ore of Uranium.

C. Sage communicated to the Claſs the analyſis he made of a ſulphurous ore of uranium, of a blackiſh brown colour, without a regular form, and brought from Erbenſioch in Saxony.

This ore, which has ſome external relation to that generally known under the name of *pechblende*, is however different in its colour, which is browniſh and dull, and in exhibiting ſome pyritous points. It contains iron, the preſence of which was manifeſted by the magnet, after the torrification neceſſary to diſengage the ſulphur.

It reſults from the different trials to which this ſubſtance was ſubjected by C. Sage, that 100 parts of it contain 78 of uranium, 20 of iron, and 2 of ſulphur.

Thinking, like all thoſe who poſſeſs any elevation of mind, and a philoſophical ſpirit in cultivating the ſciences,

that

that it is more proper to conſecrate the names of men who have enriched them by their diſcoveries, than thoſe of the fabulous deities, and great men who reſemble theſe deities in a great many points, C. Sage wiſhed that the name of *uranium* given to this metal by the Germans, who call the planet diſcovered by Herſchel *Uranus*, might be changed. In applauding theſe motives, it will perhaps be found that the names of celebrated men ought to be aſſigned to thoſe things which have been the particular objects of their attention, and that Klaproth, who diſcovered this metal, has a greater right than any other to diſtinguiſh it by his name. The French ſeem conſtantly to agree in giving the name of Herſchel to the planet which he brought from that obſcurity under which it had been concealed for ſo many ages; and, by the effect of the ſame ſentiment of juſtice, the names of Piazzi and Olbers will undoubtedly remain to thoſe diſcovered by theſe aſtronomers.

Zoologiſts and botaniſts now conſecrate to their maſters and friends the genera or ſpecies which they diſcover; and mineralogiſts no doubt will ſoon follow their example. The name of *Scheele*, ſo juſtly celebrated, has already been ſubſtituted for that of *tungſten*.

ANATOMY.

Artificial Preparations in Wax.

The art of imitating anatomical preparations with wax, of little uſe when applied to objects eaſy to be obtained by diſſection, and which may be daily procured, ſuch as thoſe of the moſt viſible parts of the human body, becomes important when applied to the repreſentation of things rare or difficult to be obtained, ſuch as the different objects of comparative anatomy, or of things accidental and tranſient, as monſtroſities and uncommon diſeaſes. In the laſt place, it is almoſt indiſpenſable to make known to pupils certain parts of ſuch a complex nature, that the demonſtrator cannot develop the whole in one diſſection.

It is to this laſt claſs that we muſt refer the lymphatic veſſels. The ſucceſs of injecting them is ſo variable; the quickſilver employed for that purpoſe is ſo inconvenient, in conſequence of the fluidity it retains: in a word, it is ſo rare that it can be made to penetrate to the laſt ramifications of theſe veſſels, even in one limb, that it is only by repeating theſe operations for a long time, and on a great number of ſubjects, that it has been poſſible to become acquainted with the whole of this vaſcular ſyſtem. Natural pieces, prepared

with the greateſt care and ſucceſs, ſoon alter, becauſe the mercury abandons their upper parts to accumulate itſelf in the lower, the veſſels of which it dilates and ruptures. Young anatomiſts then cannot, without the aſſiſtance of the arts of imitation, acquire elementary notions on this object. The caſe is the ſame in regard to preparations of the nervous ſyſtem, though leſs difficult to be made from bodies, but which, by deſiccation, are ſoon rendered indiſtinct, and almoſt uſeleſs.

It has long been found that anatomical preparations, executed in wax, are thoſe which exhibit, in the cleareſt manner, the qualities of ſuch objects, namely, all their dimenſions and all their colours; while other imitations, ſuch as common ſculpture, engraving, and even painting, beſides that they are not of a nature ſo delicate as thoſe of wax, cannot expreſs, at the ſame time, theſe two orders of qualities. Hence this method has been excluſively preferred to all others, and has been employed to form collections already celebrated. But ſeveral of them, while they give us reaſon to admire the hand of the artiſt, leave room ſometimes for regretting that it was not directed by the anatomiſt familiariſed with all the details of diſſection.

The union of theſe two kinds of talents in the perſon of C. Laumonier, aſſociate of the Inſtitute, has given great merit to three pieces which he ſubmitted to the inſpection of the Claſs; namely, a lower extremity, in which he has repreſented the muſcles, the ſuperficial veins, the extremities of the arteries, and the lymphatic veſſels; a head, exhibiting the cranium open, and the brain covered on the one ſide by the dura and pia mater, and uncovered on the other. The face and neck are prepared in ſuch a manner, as to ſhow chiefly the facial nerve, the eight pair, and the cervical branches. Another head, open at the height of the orbits, preſents a ſection of the poſterior lobe of the brain, and a portion of the cerebellum, cut above its tentorium. It was prepared with a deſign to exhibit the origin of the great ſympathetic nerve, and more particularly the cavernous ganglion, diſcovered by the author, and deſcribed with all its communicating branches in the *Journal de Phyſique*.

Theſe pieces, executed by the order of government for the School of Medicine, form a continuation of others which have been depoſited there for ſome years, and which are not inferior in point of merit.

MEDICINE.

MEDICINE.

Chemical and Medical Experiments on the Diabetes Mellitus.

Life, that phyſical, mechanical, and chemical proceſs, ſo complex, exhibits in its aberrations, as in its perfect accompliſhment, phænomena which are as much intereſting to the philoſopher as the phyſician. It is under this double point of view that C. Nicolas, aſſociate member of the Inſtitute, and profeſſor of chemiſtry in the central ſchool of Calvados, and Dr. Guedeville, have conſidered the *diabetes mellitus*, or the *pthyſuria ſaccharina*.

The preſence of the ſaccharine matter, which, for a long time, was found only in the ſugar cane (*Arundo ſaccharifera*, Linn.), has, by the labours of modern chemiſts, been diſcovered not only in many other vegetable ſubſtances, ſuch as the mallow, the juice of the maple, beet-root, &c. but alſo in the mineral kingdom, where C. Vauquelin has proved its exiſtence by his analyſis of the emerald and aigue-marine. Some products of the analyſis of milk had ſhown an analogy between it and ſugar. Dr. Willis remarked, that, in the morbid affection in queſtion, the firſt ſymptom of which is a ſuperabundant evacuation of urine, this fluid aſſumed a ſweet ſaccharine quality, inſtead of the acrid and pungent ſavour which it has in general.

C. Nicolas and Dr. Guedeville, in the courſe of their practice, having met with patients attacked by diabetes, undertook a comparative analyſis of the urine voided in the diabetic ſtate and in that of health. They aſcertained, by careful experiments, the exiſtence of the mucous ſaccharine matter in the former: they extracted from it acetous acid and alcohol, while in the ſecond it is not ſuſceptible of fermentation, either vinous or acid.

The memoir of C. Nicolas and Dr Guedeville, which may be conſidered as a complete treatiſe on the diabetes mellitus, contains a hiſtory of the cauſes aſcribed to this diſeaſe, and the means employed to combat it ſince the days of Hippocrates to the preſent time; and an exact deſcription of the ſymptoms it exhibits at its different ſtages; the principal reſults of their important labour on this diſeaſe, obſervations of which would be leſs rare were it not for the negligence of many phyſicians, who commit into the hands of quacks and *urine doctors* the unfortunate patients attacked by it.

The principal cauſe of the diabetes mellitus, which ſeems to be moſt frequent in countries where cyder, or liquors of that kind, is drunk, is a ſpaſmodic and continual deviation

of the unanimalized nutritive juices to the urinary organ, which alters alſo the gaſtric, pancreatic, biliary, &c. juices. It ſeems to be peculiar to muſcular temperaments. Its ſeat is placed in the ſyſtem of digeſtion; and the urinary organ, by the exceſs of its evacuations, ſupplies the want of other excretions and ſecretions which are ſuſpended.

The urine which paſſes, as already ſaid, has the vinous and acetous fermentation, gives alcohol of a diſagreeable odour, a cryſtallized ſugar, the nature of which is not yet well known, inſtead of *urée*, uric and benzoic acid, which it ought to contain. Ammoniacal and phoſphoric ſalts ſhow themſelves in it only in very ſmall quantity; the blood of phtyſuric patients is exceedingly ſerous, and contains ſcarcely any ammoniacal and phoſphoric ſalts. Theſe phænomena furniſh the following indications:—

1ſt. To remove the ſpaſmodic ſtate.

2d. To reſtore to the nutritive juices the principles of animalization.

And, to accompliſh theſe ends, to ſelect the food and remedies from ſubſtances which contain azot and phoſphoric ſalts..

From theſe indications C. Nicolas and Dr. Guedeville have preſcribed to the ſubjects of their different obſervations, an animal regimen, compoſed of fat meat and milky beverages, in which phoſphate of ſoda is diſſolved. As medicines, they employed boles formed with an aqueous extract of opium and cinchona; ſometimes alſo muſk. This treatment was attended with complete ſucceſs *.

GEOLOGY.

Obſervations made on the Summit of Mont-Perdu.

The beauty of ſites exhibited by mountains, and in particular the hope of reading on thoſe awful maſſes the hiſtory of the revolutions which they ſeem to have witneſſed, or at leaſt of their reſults, continually attract towards their ſummits thoſe who have once experienced the charm of theſe meditations, which might be called antediluvian.

C. Ramond, whoſe particular ſtudy it has been to make us acquainted with the Pyrenees, and particularly Mont-Perdu, has confirmed by a new tour, that this mountain overlooks all the ſurrounding peaks.

* Thoſe who have ſeen Dr. Rollo's and Mr. Cruickſhank's valuable works on the Diabetes Mellitus, will be not a little ſurpriſed to find them not even quoted in the preceding notice, though they preſent every one of the facts that have been noticed in it as new!——EDIT.

The

The ridge of it consists of beds of black marble, filled with siliceous nodes, which here and there contain heaps of shells, the summit seems to have none of them, but they are found a little further down. These beds or banks, which are generally parallel, follow the principle direction of the chain, and are subject to flexions more or less considerable on each side of this direction. They are almost all vertical, their mean inclination being about 80° to the south.

The cap of snow which covers the peak is only about six feet in thickness, because the steepness of the lateral declivities does not admit of its accumulation; but, in parts where the ground is less steep, the thickness of the snow is 40 or 50 feet, and it is more considerable in the valleys, which catch the snow as it rolls down from the surrounding declivities.

The summit of Mont-Perdu presented to C. Ramond two plants of the phanerogamia kind, the *Aretia alpina*, Linn., and the *Saxifraga retusas*, Gorian. Lower down he found the *Cerastinum alpinum*, the *Saxifraga grœnlandica*, and the *Ranunculus pamassifolius*. He is of opinion that it is not the height of the peak, but the want of earth proper for vegetation, that renders plants so rare on the summit. He saw scarcely any thing but a few remains blasted by lightning and buffeted by the winds; and if, amidst this destruction, occasioned by the combined action of the most powerful meteors, a rock still in its place offered vegetables a firm support, it was covered by turf and plants in such a state of vigour, as proves that it is neither the want of air, nor the lowness of temperature, that banishes them from these regions.

The revolutions which this part of the globe has experienced appeared evidently to C. Ramond, to have been occasioned by the rending of the primitive mass, the salient and re-entering angles of which are still so entire and so sharp, that he thinks if the cause which disjoined them should operate exactly in a contrary direction, they would unite in such a manner, that the joining would be imperceptible.

These characters, peculiar to the mass of Mont-Perdu, "make it, says Ramond, like an island of a few leagues in extent, raised by some revolution on the back of the Pyrenees."

GALVANIC SOCIETY, PARIS.

Dr. Nauche, president of the society, with the senators Aboville and Lespinasse, has made a curious observation, which is of some importance on account of the inferences that may be deduced from it. He has found that it is possible to make a blind person, however great the degree of blindness, to perceive very lively and numerous flashes of

light, by bringing one extremity of the voltaic pile into communication with the hand or the foot, and the other with the face, the skin, of the head covered with hair, and even the neck. There exists a line of demarcation, beyond which no flashes take place.

Dr. Nauche has also confirmed with his fellow labourers, Tourlet, Legallois, Bonnet, Doussin-Dubreuil and Pajot-Laforêt;

1st. That reiterated applications of galvanism, when they comprehend the half of the trunk, produce in the person subjected to them great agitation, many reveries, involuntary tears, increased secretion of saliva, an acid or alkaline taste, a great secretion of urine, an increase of heat and transpiration, abundant sweat in the galvanized parts, great disturbance in the state of the pulse, which is accelerated, and often imperceptible at the moment of the commotions.

2d. That the action of the galvanic fluid may be increased by drawing it off by a sharp point, which does not appear to act at the moment of contact.

He has been able also to stimulate the organs separately, by directing to the nervous trunks, which distribute themselves to these organs, or which communicate with them, the two extremities of the pile, of the circle of cups or of the galvanic trough. He remarked that, by making the application a bath charged with a saline solution, a strong *galvanic bath* may be obtained, the effects of which are mild, and sometimes more advantageous than those obtained by other processes.

Paris, Dec. 17th.

In the last sitting of the Galvanic society, M. Robertson repeated experiments on the combustion of phosphorus and metals, by means of a very large pile composed of plates of copper and zinc. M. Gantherot announced that platina is a worse conductor of the galvanic fluid than iron. Medical applications were not neglected, and among the useful results the following were mentioned: The cure of a gutta serena, with which a domestic of M. Gillet-Laumont, member of the council of the mines, had been affected, by M. Nauche, the president: of a sciatica, on the coachman of the second, by M. Dudanjeon; and of a palsy in the right arm, by M. Pajot-Laforêt. The society appointed M. Laplace, Aboville, Lespinasse, Sue, Dubreuil, Paroisse and Judelot, to make experiments at the national establishment of the *Quinze-Vingts* on persons born blind.

THE

THE BATAVIAN SOCIETY OF THE SCIENCES AT ROTTERDAM.

On the 21ſt of Auguſt, the ſociety propoſed the following new prize queſtions.

1ſt. What are the phænomena obſerved in regard to the origin and progreſs of waves, in laying the foundations of piers, at greater or leſs diſtances? What means have from time to time been diſcovered, and tried with more or leſs advantage to reſtrain or to leſſen the deſtructive conſequences of the courſe of the waves? What can be deduced from theſe phænomena, for explaining the cauſe of waves; and what uſe can be made of this knowledge, to improve the means already adopted for ſubduing the waves, or to render them more powerful?—To be anſwered before the 1ſt of March, 1804.

2d. What is the reaſon that the experiments in regard to the conducting power of bodies for caloric, are ſo uncertain and often contradictory? and what is the ſureſt and propereſt method to aſcertain the quantity of this conducting power both in ſolid and fluid bodies?—To be anſwered before the 1ſt of March, 1803.

The prize for each queſtion is a gold medal of the value of 30 ducats. The papers muſt be tranſmitted, poſt paid, under the uſual conditions, to the director and firſt ſecretary of the ſociety, Oliver Chriſtian Eickma.

THE JABLOWNSKY SOCIETY OF THE SCIENCES AT LEIPSIC.

This ſociety has propoſed the following prize queſtions for the year 1803.

Hiſtory.—An account of the connection which ſubſiſted between the kingdom of Poland and the grand Duchy of Lithuania, before and after the union eſtabliſhed by the aſſembly of the States at Lublin in 1569.

Natural Philoſophy.—Hiſtorical account of the theory of attraction, and the application made of it from the time of Newton to that of Laplace.

Economy.—What foreign trees and ſhrubs, uſeful on account of their ſpeedy growth, their duration, and their fitneſs for fire-wood; or applicable to the purpoſes of dyeing, tanning, or making furniture, can be cultivated and naturalized in the German pleaſure-grounds?

The prize for each will be a gold medal of the value of 24 ducats; and the papers muſt be tranſmitted, under the uſual conditions, to profeſſor Wieland at Leipſic, before the end of February, 1803.

ELECTORAL

ELECTORAL ACADEMY OF MENTZ.

This ſociety have publiſhed a new volume of their tranſactions, 1799-1802, large octavo, with plates. The contents are, 1ſt. Chemical examination of ſome foſſils, by Tromſdorff. 2d, Experiments on a proper method of preparing cinnabar in the dry way, by Buchenholzen. 3d. A view of the principles of the Derivation Calculus of the two French analyſts, Lagrange and Arbogart, with a compariſon between it and the Differential Calculus. 4th and 5th. Homeyer's eſſay, which obtained the academical prize. 6th. Obſervation on ſome rare kinds of fern, with three plates by Wildenow. 7th. On the *Aſplenium*, and ſome plants of the ſame family, by Bernhardi. 8th. Obſervations on ſtripping off the bark of fruit trees as the means of increaſing their produce. 9th. On the action of common ſaltpetre and common ſalt on animal bodies, by Thilow. 10th. Examination of the origin of harmony, and its progreſſive formation, with three plates. 11th. Stuffo, no deity of the Thuringians, by Wolf. 12th. Eloge of M. A. H. Frank, by Bellerman.

ROYAL ACADEMY OF SCIENCES AT BERLIN.

The following papers have been read before the Society ſince the commencement of the preſent year:—

Jan. 7. A continued account of the new planets, by profeſſor Bode. 14. On the noble pride of men of letters, by the director de Caſtillon. 21. A paper on the queſtion, To what extent were the antients acquainted with the art of painting? by counſellor Hirt. 28. A public ſitting. M. Merian read the eloge of Mr. Selle; M. Teller, the eloge of M. von Wöllner; profeſſor Bode, a hiſtory of the diſcovery of the new planets; profeſſor Klaproth, an examination of the laſt experiments on galvaniſm.

Feb. 4. A chemical examination of the calculi found in the ſtomachs of horſes. 11. On the certainty of the mathematical ſciences, by profeſſor Burja. 18th. A continuation of moral and philoſophical thoughts, by M. Ancillon. 25. On the means of promoting mental culture in the ci-devant Poland, by M. Gedike.

March 4. A ſuccinct account of the manner in which the vaccine has been introduced, brought into repute, and propagated at Vienna, by Dr. De Carena; read by M. Walter, junior. 11. Obſervations on the developement of the functions which contain multiple ſines and co-ſines of arcs. 18. On the oldeſt evidences of geology and phyſiology, and particularly men; by M. Trembley. 25. On ſome words of number, and their etymology; by M. Baſtide.

April

April 1. Some obſervations on the cow-pock; by Dr. Hufeland. 8. On ſome elementary theorems of philoſophy; by M. Gruſon. 29. On the influence of the will; by M. Klein.

May 6. On the genealogy of the houſe of Pruſſia, 4th period; by M. Verdy. 13. An examination of the queſtion, What is manuring? by M. Hermbſtadt. 20. Experiments towards aſcertaining the nature of ſome vegetable alkalies; by M. Bernoulli. 17. On improving the regulations in regard to criminals; by M. Zollner. 24. On the art of dreſſing; by count de Guyon.

July 1. A ſecond memoir on artificial meadows; by M. Baſtide. 8. Aſtronomical intelligence; by profeſſor Bode. 15. Reflections and general principles in regard to manufactures and excluſive privileges; by M. de Caſtillon. 22. On ſynonyms, and the richneſs and elegance of languages; by the abbé Denina. 24. On the black gum of the elm-tree; by profeſſor Klaproth.

Aug. 5. A public ſitting. The eloge of M. de Carmer, and the eloge of M. de Moulines; by Dr. Merian. On the antiquity and riches of the German language; by the abbé Denina. On the organs of ſmell in man and in animals; by M. Walter, junior.

Sept. 16. Some remarks on the ſoul of man; by M. Prevoſt, of Geneva. Account of the new planet of Olbers; by profeſſor Bode. 23. A fourth memoir on hiſtorical problems; by M. de Chambrier. 30. Geographical obſervations on the county of Hohenſtein; by M. Gerhard.

XLIII. *Intelligence and Miſcellaneous Articles.*

MEDICINE.

WE copy the following article from an Edinburgh paper; it is an extract of a letter ſigned Civis:

"While I was at Smyrna there was a girl afflicted with a cancer in her lips, and the gum was affected. The European phyſicians conſulted on the meaſure to be taken, and agreed that they ſaw no other method than to cut it out; and the girl had already ſubmitted herſelf to that deciſion. By an accident of that nature which men cannot account for, an old Armenian came to them juſt in time to prevent the application of the knife. "Do nothing," ſaid the Armenian, "I will cure her;" and when he had pledged himſelf ſtrongly, the phyſicians conſented. He procured a copper veſſel

veſſel newly tinned in the inſide (an eſſential circumſtance), and having poured a certain quantity of olive oil into it, he made it boil over a ſmall fire, ſufficient to keep it gently agitated; and ſo for three times in twenty-four hours. With this the oil reſolved itſelf to the conſiſtency of an ointment, and, by conſtantly rubbing the part affected, he cured her in fourteen days.—Nothing elſe was done.

The phyſicians ſuppoſed that the oil received its virtue from the tin, and that it was communicated by its long boiling over the fire."

ON THE WEAVIL IN SEA BREAD.

The fatal effects of the weavil in ſea bread have long been ſeverely felt by ſeamen employed on long voyages: rewards have been humanely offered by the legiſlature for a cure or preventative, but hitherto without ſucceſs. The following fact was diſcovered by accident, and is now offered to the public as a hint worthy the attention of thoſe who may be employed in ſupplying ſhips with proviſions, or to captains and the owners of veſſels, and may, in all probability, leſſen, if not wholly remove, an inconvenience ſo injurious to our invaluable navigation:—A bag belonging to a powder-mill fell into a cauldron of liquid nitre; it was immediately taken out, plunged into cold water, and hung up to dry: ſeveral days after this circumſtance the bag was filled with ſea-biſcuit and ſent on board a Weſt Indiaman, where it was ſtowed away amongſt the captain's ſtock. The veſſel was nine months out of England before ſhe proceeded on her paſſage home, when ſhe got becalmed, and remained ſo long in that ſituation, that her crew were forced to be put on half allowance, more particularly ſo, as their bread was much deſtroyed by the weavils, and was hourly conſuming. The captain at this time wiſhing to make uſe of the bag above mentioned, which had not been opened ſince the ſhip left England, ordered it to be examined, when, greatly to his ſurpriſe, the whole contents were found to be perfectly ſound, without any appearance of having been injured by any inſect whatever; a circumſtance ſolely to be attributed to the quality of the bag.

ANTIQUITIES, &c.

A number of rare manuſcripts and other valuable articles have been brought to this country by Mr. Cripps, of Suſſex, and the Rev. Mr. Clarke, which we underſtand are principally intended to enrich the library of Jeſus college, Cambridge. The whole collection made by theſe gentlemen, illuſtrating

luſtrating the natural and moral hiſtory of the various people they viſited, in a journey from the 69th degree of north latitude to the territories of Circaſſia and the ſhores of the Nile, fills 183 caſes. The botanic part contains the herbary of the celebrated Pallas, enriched by the contributions of Linnæus, and his numerous literary friends. With the minerals are ſeveral new ſubſtances, and the rareſt productions of the Siberian mines. Among the antiquities are various inſcriptions and bas-reliefs, relative to obſervations made in the plain of Troy, and which were announced by M. Chevalier, in France, in the laſt edition of his work. The medalic ſeries contains ſeveral coins of Greece, and of the kings of Parthia, hitherto unknown. The manuſcripts are in Hebrew, Coptic, Arabic, Abyſſinian, Perſian, Turkiſh, and the language of Thibet Tartary: and in the Greek and Latin languages are ſeveral manuſcripts of the claſſics, of the goſpels, and the writings of the earlieſt fathers of the church. In addition to theſe, the collection contains Greek vaſes, gems, ſculptures, and many remarkable Egyptian monuments, from the ruins of the city of Sais, diſcovered by theſe travellers in the Delta after the evacuation of Egypt by the French: alſo numerous original drawings, maps, charts, plans, models, and ſeeds of many rare and uſeful plants; the habits, utenſils, idols, of the inhabitants of the Aleutan iſles, brought by Billings to Ruſſia after his expedition to the countries lying between Kamtſchatka and the north-weſt coaſt of America, with many geographical obſervations, the publication of which was ſo long withheld by order of the Ruſſian government.

ON THE APPARENT ATTRACTION OF FLOATING BODIES. By a Friend to Phyſical Inquiries.

It is a well known fact, that when bodies which are afloat upon water come within a ſmall diſtance of each other, they will ſuddenly ruſh together: this ſudden approach has uſually been attributed to a mutual attraction of the floating bodies; and it is common to float two cork balls in a veſſel of water, for the purpoſe of demonſtrating this ſuppoſed attraction. A few years ago the following experiments were made, with a ſtrong perſuaſion that the abovementioned circumſtance was not owing to the attraction of the cork balls; and if any one who is now of opinion that it is owing to a mutual attraction of the balls, will make the experiments themſelves, it is probable that they will have doubts on the ſubject, or totally alter their opinion.

1. June 1797. Two cork balls (one larger than the other conſiderably) were floated on water: when brought near

each other, they approached in the uſual manner, as if by ſome mutual influence. This was expected.

2. The larger ball was ſtuck on a piece of wire, and was holden near the ſmaller one, which was floating whilſt this (the larger one) was entirely out of the water. There was, under theſe circumſtances, not any apparent attraction whatever.

3. The larger ball on the wire was then totally immerſed in the water, and, though near the other ball, there was not any apparent attraction.

4. The ball on the wire was then raiſed *partly* above the ſurface of the water near the floating ball; then the ſmall ball approached, and the uſual appearance of attraction took place.

The following is offered as an explanation of the above facts; and is ſuppoſed to be the chief, if not entire cauſe, of thoſe effects:

Round each cork ball, when floating on water, may be ſeen an elevated circular maſs of water, raiſed probably from the ſame cauſe (whatever that may be) by which water riſes in bread, ſugar, &c.: now it appears that when theſe two circular maſſes or rings of water touch each other they unite, and, by endeavouring to form one maſs, carry the two cork balls with them until they touch.

London, Nov. 2, 1802.

GALVANISM.

On the 20th of November profeſſor Aldini repeated, in two courſes, at Mr. Wilſon's anatomical theatre, Great Windmill-ſtreet, formerly that of the celebrated Dr. Hunter, the galvanic experiments which he performed before the French National Inſtitute, and lately at Oxford. The firſt courſe, deſtined for the medical ſtudents, was opened by Mr. Wilſon, who preſented profeſſor Aldini to his pupils, with ſome obſervations on his intereſting diſcoveries. The ſecond courſe, which commenced immediately after, was honoured by the preſence of his excellency general Andreoſſi, ambaſſador of the French republic, accompanied by ſeveral gentlemen of his ſuite; M. Argyropoli, charge d'affaires of the Ottoman Porte, Sir William Hamilton, Dr. George Pearſon, Dr. Lettſome, and a great many other gentlemen. Mr. Cuthbertſon aſſiſted the profeſſor in arranging the apparatus, and Mr. Hutchins, a medical pupil, provided the anatomical preparations. The experiments were performed with neatneſs and preciſion, and gave much ſatisfaction to the ſpectators, who teſtified their approbation by loud and repeated applauſes.

XLIV. *Analyſis of the Schieferſpath from Cornwall; to which is prefixed an Analyſis of Carbonated Lime, and Remarks on the Means which have been employed to aſcertain the Quantity of Carbonic Acid contained in it.* By Mr. RICHARD PHILLIPS, *Member of the Britiſh Mineralogical Society**.

FROM ſome experiments made upon the ſchieferſpath, I was induced to believe that it conſiſted of lime combined with a much greater quantity of carbonic acid than, according to the analyſis of Bergman (Eng. edit. vol. i. p. 32.) is contained in carbonated lime. I refer to his analyſis of this ſubſtance, ſuppoſing it to be the laſt, and perhaps the only one ever made of it, ſince it is quoted by Haüy, *Traité de Mineralogie*, tome ii. p. 128; and by Brochant, tome i. p. 548, as well as by other late writers on the ſubject. By the analyſis of Bergman, pure carbonated lime conſiſts of

Carbonic acid	-	34
Lime	-	55
Water	-	11
		100

In order to aſcertain the quantity of water, which, as above ſtated, is very conſiderable, the following experiments were made:

Exp. I. 100 grains of pure carbonated lime (double refracting ſpar) were expoſed, in a ſilver crucible, to a red heat for about twenty minutes. On weighing them when cold they were found to have diminiſhed 1·8 grain. It will hereafter be ſhown that a part of this loſs was probably water: yet a portion of it is to be attributed to the diſengagement of carbonic acid; for, upon putting the remaining carbonated lime into water coloured blue by ſyrup of violets, the ſolution inſtantly aſſumed a deep green colour. Hence it appears that this method is not to be relied upon in order to diſſipate water only.

Exp. II. 400 grains of carbonated lime were introduced into a coated glaſs retort, having a receiver adapted to it. Soon after the application of heat, a very minute quantity of water appeared in the neck of the retort; but it was entirely diſſipated before it had reached the mouth of it. Owing to this, and the extreme ſmallneſs of the quantity, it was entirely impoſſible to aſcertain or even to eſtimate its weight. No more water appeared upon the application of a much ſtronger

* Communicated by the Author.

heat to the retort. This experiment was repeated with ſimilar reſults.

Exp. III. To find the quantity of carbonic acid contained in carbonated lime, I made uſe of a veſſel nearly ſimilar to that deſcribed in *page 365 of the 12th volume of the Philoſophical Magazine.

Into this veſſel was put a ſufficient quantity of nitric acid of the ſpecific gravity 1·40, noting at the ſame time the aggregate weight of the vial, tube, and acid; and 100 grains of fragments of carbonated lime were gradually added to the nitric acid. When the laſt portions of it were decompoſed, on weighing the vial, &c. it had received an addition of 56 grains. Hence 44 grains, which were carbonic acid, were expelled. On repeating this experiment with quantities of carbonated lime greater than 100 grains, proportional reſults were afforded.

Exp. IV. To determine the quantity of lime, 100 grains of carbonated lime reduced to powder were put into a platina crucible, and ſtrongly heated in a wind-furnace for about two hours: the reſiduum was pure lime; it weighed 55·9 grains. Upon repeating this experiment I obtained a reſiduum weighing 55·05 grains. Theſe reſults differ but little: their mean, 55·475, is therefore aſſumed as the quantity of lime contained in 100 parts of the carbonate.

According to the above experiments, carbonated lime contains

Carbonic acid -	44
Lime - -	55·475
Water and loſs	·525
	100·000

In comparing the above with the analyſis by Bergman there appears a difference of 10 of carbonic acid and nearly 10·5 of water. Kirwan, (Mineralogy, vol. i. p. 87.) on remarking the difference of the quantities of carbonic acid obtained by himſelf and Bergman, ſuppoſes the latter employed ſulphuric acid to diſengage the carbonic: and this conjecture ſeems well founded; for, if carbonated lime be put into ſulphuric acid, the ſulphate of lime formed, and falling down inſoluble, ſo envelops a part of the carbonated lime that the complete action of the ſulphuric acid is prevented: and as it does not appear that Bergman obtained the water by direct experiment, he ſeems to have aſſumed its quantity

* The experiments there related upon the ſatin ſpar were repeated; but it did not appear to contain more than the uſual proportion of carbonic acid.

from

from the deficiency occaſioned by the incomplete action of the ſulphuric acid.

Still apprehending that reſults ſo diſſimilar might ariſe from inaccuracy in the method I had employed, more minute attention was paid to the diſengagement of the carbonic by the ſtronger acids. The following experiment was inſtituted to determine the quantity of muriatic acid carried over by the effervescence it excited. This acid was preferred to the nitric for two reaſons: being very dilute, and its action conſequently increaſed, the error is ſhown in its greateſt degree; and ſmall quantities of it are much more readily detected than of nitric acid.

Exp. V. 200 grains of fragments of carbonated lime were put into muriatic acid of ſpecific gravity 1·17 in the vial already mentioned, having a Woulfe's apparatus ſo adapted that the carbonic acid diſengaged might paſs through water. After the effervescence had ceaſed, the vial containing the muriate of lime was heated in water for nearly an hour, in order to expel the carbonic acid, which, although diſengaged from the lime, was held in ſolution by the water of the dilute muriatic acid. By theſe means the loſs was ·6 more than when nitric acid of 1·40 was uſed, occaſioned by the more rapid effervescence.

To the water through which the carbonic acid had paſſed nitrate of ſilver was added, which occaſioned the formation of ſuch a quantity of muriate of ſilver as, from comparing the degree of turbidneſs, was nearly equalled by ·6 of muriatic acid. The ſlight diſſimilarity evidently reſulted from the evaporation of the water of the muriate of lime by the heat employed to extricate the laſt portions of carbonic acid.

The ſtronger effervescence which a dilute acid excites, is not the only inconvenience attending it; the water is capable of combining with a quantity of carbonic acid, which renders it neceſſary to employ heat, as in the above-mentioned experiment, which is totally unneceſſary when a concentrate acid is made uſe of.

Analyſis of the Schieferſpath.

Some fragments of ſchieferſpath being put into muriatic acid, ſtrong effervescence took place, and nearly the whole was ſoon diſſolved: the ſolution was colourleſs; a very minute quantity of a finely divided white ſubſtance remained undiſſolved. The ſolution, divided into parts, exhibited with reagents the following appearances:

Pruſſiate of potaſh, a blue precipitate.

Tincture of galls, a dark brown precipitate.

Ammonia, a ſmall quantity of reddiſh brown precipitate.

Oxalate of ammonia, a copious white precipitate.

Sulphuric acid and ſulphate of ſoda both produced plentiful white precipitates; the latter not immediately: the ſolution, therefore, contained neither ſtrontia nor barytes.

Carbonate of potaſh alſo occaſioned a plentiful white precipitate: upon heating the ſolution after filtration no further depoſition took place, as would have done had the ſolution contained magneſia.

The inſoluble white reſiduum was boiled in ſulphuric and nitric acids, but neither of them diſſolved any part of it: potaſh diſſolved it entirely: had it been alumina, its ſtate of extreme diviſion would have admitted of its eaſy ſolution in acids: it therefore appears to be ſilica. The ſame appearance took place with ſolution of the ſchieferſpath from Germany.

From theſe preliminary experiments it appears that the ſchieferſpath is a carbonated lime intermixed with oxide of iron and a very ſmall quantity of ſilica; ſo ſmall, indeed, that, had it not always appeared in every ſolution which was made of the foreign as well as the Engliſh, I ſhould have been induced to ſuſpect that its preſence was rather accidental, than neceſſarily entering into the compoſition of the mineral.

Employing the method which has already been mentioned, 200 grains loſt by ſolution in nitric acid of 1·40 ſpecific gravity 86·8 grs. of carbonic acid, equal to 43·4 per cent. Now, according to the analyſis juſt given of carbonated lime, 44 parts of carbonic acid are united to 55·475 of lime: hence 43·4 of carbonic acid muſt be combined with 54·718 of lime, forming together 98·118 of carbonated lime.

The nitric ſolution was conſiderably diluted with water, in order to effect more readily the ſubſidence of the ſilica; which being carefully collected, after repeated waſhing, and dried in a glaſs veſſel by the heat of an Argand's lamp, weighed ·1 of a grain, equal to ·05 per cent.

The oxide of iron precipitated by ammonia was ſubmitted to a red heat, and treated with carbonaceous matter ſo as to render it magnetic: on weighing, it was found equal to ·8 per cent. 100 parts conſiſt of

Carbonate of lime -	98·118
Silica - -	·05
Oxide of iron - -	·8
	98·968
Loſs - -	1·032
	100·000

XLV. *De-*

XLV. *Description of the Schieferspath. By* ARTHUR AIKIN, *Esq. Member of the British Mineralogical Society.*

SCHIEFERSPATH: Calcareus spathum schistosum: *Werner.* Argentine: *Kirwan.* Spath schisteux: *Brochant.*

Colour: very dilute yellowish white; by being kept for a few minutes in a red heat, it becomes slightly reddish white.

Lustre, internal; shining pearly.

Fracture: waved-lamellar.

Fragments: for the most part blunt-edged, wedge-shaped: it is translucid even when in mass, and at the edges is occasionally transparent. It is brittle; may be scratched by the nail, and has a slightly unctuous feel: specific gravity 2·740.

This mineral differs from common calcareous spar in its superior brilliancy; and especially in the total absence of the rhomboidal figure in its fragments. The specimen analysed *, and from which the above description was taken, differs from the general account of this mineral by Widenman, Emmerling, Brochant, &c. in being more transparent: it is probably from Polgorth tin-mine, and is covered in various parts with crystallized oxide of tin and chlorite: on breaking the specimen, a small quantity of fluor spar was found. It may be well to remark, that Cornwall, and probably the same mine, has produced a calcareous spar of the usual rhomboidal fracture and of a brilliant pearly lustre: it contains no silica, and appears to be lime combined with the usual quantity of carbonic acid and a little oxide of iron: specific gravity 2·723.

XLVI. *A short Account of Mr.* SMITH'S *Air-pump Vapour-bath. By Mr.* HENRY JAMES.

To Mr. Tilloch.

PERMIT me, Sir, to lay before the readers of your Magazine such an account of a *Philosophical Apparatus* (not less useful than ingenious) as may in some measure correspond with the general intention of so valuable a publication.

The *Air-pump Vapour-bath*, after fifteen years almost constant attention, and at a very considerable expense, has at length been brought to such a degree of perfection as to be applicable, with good effects, in some of the most distressing complaints to which suffering humanity is liable. The application of this apparatus is now at length committed to the direction of medical men, so that, I trust, its good properties will not, as heretofore, be overlooked; or, what amounts to

* See the preceding article.

the ſame thing, will not, from want of profeſſional diſcrimination, be ſuffered to ſink into oblivion. With this part of the buſineſs, not being a medical man, I have nothing to do: leaving it, therefore, in better hands, I ſhall attempt, 1ſt, Some account of its origin; 2dly, What, *à priori*, might have been expected from it in a philoſophical point of view; and, laſtly, Such an explanation of its principles as, I hope, may prove that it has a fair claim to its daily increaſing popularity.

1ſt. Mr. Smith, of Brighton, my father-in-law, from the ſtory of king Edward, at the cruſades, having had the poiſon of an arrow ſucked from a wound by the mouth of his fair queen, long ago conceived the idea of this Apparatus. His firſt attempts at putting it in execution were rude, and almoſt laughable: but the great engine of his mind, on this as on other occaſions, roſe ſuperior to all difficulties; and at length the accompliſhment of his object rewarded his perſeverance: for what will not perſeverance achieve!

With every poſſible reſpect for the faculty, may we not here take the liberty to expreſs our ſurpriſe that they ſhould have left this extenſion of the powers of the cupping-glaſs to be diſcovered by an individual altogether unacquainted with the principles of their ſcience? For the intelligent reader will preſently be informed, that the Air-pump Vapour-bath acts upon the ſame principle as the cupping-glaſs; and, to uſe the inventor's own words, "is neither more nor leſs than a cupping-glaſs on a large ſcale." This deſcription is accurate as far as it goes; but Mr. Smith did not at the time take into account, that by means of his apparatus, fomentation can be applied, and its temperature regulated, with a degree of certainty and accuracy which, I apprehend, were never attained, or ſo much as expected, before this happy diſcovery. For I think it requires little ſagacity to obſerve, that in fomenting with flannels the temperature can never be for a minute equably preſerved; but the limb muſt be expoſed to various degrees of heat and cold during the application.

2dly, To thoſe of your readers who have viſited the tops of high mountains, it is unneceſſary to deſcribe the effects of the diminution of atmoſpheric preſſure. M. de Sauſſure, who has publiſhed an intereſting account of his journey up Mount Blanc, ſtates it moſt forcibly. He found that the mercury in his barometer ſunk to 16 inches and a line (17·145 inches Engliſh), and that the air had conſequently little more than half the preſſure of that on the plains. In ſuch ſituations, the arteries on the ſurface of the body, deprived of their accuſtomed

tomed preſſure, do not, as uſual, reſiſt the impetus given to the blood by the contraction of the heart, which has been found to occaſion difficulty of reſpiration, violent retching, and even vomiting of blood.

I need not tell you, that the preſſure of the atmoſphere in its mean ſtate is equivalent to a weight of 15 pounds to every ſquare inch. It has thence been computed, that the preſſure of the circumambient fluid upon the ſurface of the whole earth is equivalent to the weight of a globe of lead 60 miles in diameter. If every ſquare inch of the human body, therefore, ſuſtains a preſſure of 15 pounds, every ſquare foot muſt ſuſtain that of 2160 pounds; and according to this calculation, every ordinary ſized man has to ſupport a weight of between 15 and 16 tons for his common load. Such an enormous preſſure, if not counterbalanced by the elaſticity of the air within our bodies, would cruſh us in a moment. If a portion of this preſſure be removed from any part of the body, as is the caſe, for inſtance, when a leg or arm is encloſed in the cylinder of this Apparatus, and the air partially extracted, the effect of this unequal preſſure ſoon becomes perceptible to the patient. Should the exhauſtion be carried to its utmoſt extent, it requires no ſtretch of imagination to conceive the effects that would be produced!

The quantity of atmoſpheric preſſure on the human body ſometimes varies near a whole ton, from natural cauſes. When it is diminiſhed ſo much, many people, particularly the nervous, find themſelves inactive and irritable. It is ſomewhat ſurpriſing that the ſpring of the internal fluid, mentioned above, as counterpoiſing atmoſpheric preſſure, ſhould exactly balance it when artificially augmented, and even when naturally diminiſhed, but not when *artificially* diminiſhed. Thus, though we perceive no evident diſtenſion of the blood-veſſels on the ſurface of the body from the natural diminution of atmoſpheric preſſure; yet the caſe is widely different when the diminution is artificially produced, as can be effected to any extent within the cylinder of this Apparatus. Thus animals in the receiver of an air-pump become immediately uneaſy, and can live but a very ſhort time in air artificially deprived of no more of its preſſure, than by the barometer, appeared to take place on the top of Mount Blanc. I am aware that this phænomenon may be accounted for on other principles; namely, that a certain quantity of oxygen gas diffuſed through a given ſpace, will not ſuſtain animal life half ſo long as twice the quantity diffuſed through the ſame ſpace. There may be ſomething in this; but, I humbly think, it is not ſufficient alone to account for

the immediate uneaſineſs and early death of the encloſed animal.

What proportion of theſe conſequences is to be attributed to retarding the impetus of the blood returning to the heart, and conſequently producing an earlier collapſe of that organ, I leave to anatomiſts and phyſiologiſts to determine.

It was once the faſhion among phyſicians to explain the functions of the human body by mechanical principles alone; to conſider it as an hydraulic machine, and its fluids as aſcending and deſcending by the ordinary powers of ſuch engines. From having applied the laws of dead matter to the functions of the living body too extenſively, they bewildered themſelves, and contradicted each other. Nevertheleſs, in this age of perfected anatomy and improved phyſiology, we find Dr. Darwin, who is ſaid to have done as much for the latter ſcience as ſir Iſaac Newton did for natural philoſophy, propoſing "to ſtill the action of the heart and arteries by mechanical means." This, he ſuppoſes, may be effected by ſuſpending a bed ſo as to whirl the patient round, with his head neareſt the centre of motion. For this purpoſe, a perpendicular ſhaft might have one end paſs into the floor, and the other into a beam in the ceiling, with a horizontal arm, to which a ſmall bed might be attached. The effects of whirling a patient in this ſituation, ſo as by the centrifugal force to propel the blood from the ſuperior into the inferior parts of the body, would certainly be conſiderable, and, he obſerves, might probably add to the means of curing fevers.

Be this as it may, the relief which many perſons have experienced from the uſe of the *Air-pump Vapour-bath*, authorizes me to affirm, that it is capable of producing, with eaſe and ſafety to the patient, all the good effects which Dr. Darwin could poſſibly expect from his centrifugal machine.

It would neither be compatible with my attainments, nor your plan, to deſcribe the medical uſes of the *Air-pump Vapour-bath*. I ſhall therefore barely mention, that it has been found extremely beneficial in a variety of diſeaſes ſpecified in a treatiſe lately publiſhed, intitled, "Facts and Obſervations reſpecting the Uſe of Smith's Air-pump Vapour-bath in Gout, Rheumatiſm, Palſy, &c. &c."

Laſtly, It only remains that I offer you ſome explanation of the mechanical principles of the Apparatus, according to the references on the annexed plate.

Explanation of the Plate.

Fig. 1. (Plate VII.) a view of that end of the machine to which the exhauſter, &c. are affixed. A, the body of the machine.

machine. B the boiler containing the fluid, the fumes of which are thrown into the cylinder, through the ſtop-cock H, and heated by means of a ſpirit lamp C, which ought always to be withdrawn immediately on turning the ſtop-cock G, hereafter mentioned. D a thermometer, ſhowing the temperature of the fumigation. E the exhauſter for producing a partial vacuum within the cylinder, after the fumigation has continued a proper time. F the eſcape-valve of the exhauſter, to which a flexible pipe is adapted to convey the air from the chamber, if vitiated by the nature of the affection for which the application is made. G the ſtop-cock of the boiler. H another ſtop-cock to prevent the valves of the exhauſter from being injured by the hot fumes, as they enter the machine during the fumigation.

Fig. 2. a perſpective view of the machine from the other end, where the limb is admitted. I the body of the machine, made of ſtrong copper tinned in the inſide, ordinary tinned iron itſelf not being ſufficient, in all caſes, to reſiſt the preſſure of the atmoſphere. K the mouth of the machine, to which is attached a ſtrong bladder, cut ſo that one end of it may go over, and be firmly ſecured to it by means of a ligature; the other ſo that it may be drawn over the limb, when paſſed through it into the machine, and ſecured upon it by means of a roller.

The conſtruction of the machine juſt deſcribed, is adapted to the leg or arm only. Its principle, however, may be extended, and one might be made to include a greater portion of the body. Such an attempt is making. One of the moſt obvious conſequences of its application muſt be, a temporary expanſion of the veſſels of the part from whence ſo great a preſſure is removed. This muſt powerfully aſſiſt nature in removing obſtructions formed in them, which often ſpeedily produce inflammation, and terminate in ſuppuration and abſceſs.

Dr. Hamilton, of the London Diſpenſary, has obſerved, that the mode in which it muſt act is agreeable to ſound theory, and that the more it is applied to practice, the oftener will facts occur to recommend it. That eminent phyſician "not only views it as valuable to remove local affections of the extremities, but alſo to afford relief in other parts of the body, where obſtructions may have taken place." In the ſame letter he obſerves, that "the machine, by having a condenſing pump fixed to it, may be uſed as a bracer, and that with beneficial and powerful effects." This may be done merely by reverſing the valves in the pump.

Theſe

Thefe conſiderations, however, I ſhall leave to your medical readers, to whom I wiſh to ſubmit this important query —*Is the application of the principle juſt alluded to, ever likely to be of uſe in relieving the ruptured?*

No. 5, Cumberland Place,
New Road, Marylebone,
January 8, 1803.

I am, Sir, yours, &c.
HENRY JAMES.

XLVII. *Memoir on the Supply and Application of the Blow-pipe. By Mr.* ROBERT HARE *jun. Member of the Chemical Society of Philadelphia.*

[Concluded from p. 245.]

THE hydroſtatic blow-pipe may be filled with any of the gaſes, by exhauſting them from the inverted jars of the pneumato-chemical apparatus: and if it be deſired to confine different ſpecies of gas, by cloſing the cock of communication between the compartments, one of them may be filled with one kind of gas, and afterwards, by turning the hood, the other compartment may be filled with another kind. To make this underſtood, let *a*, fig. 5, be a pneumato-chemical tub, with a ſhelf *c*, and an inverted glaſs jar *b*. Suppoſe that the tub were filled with water, and the jar with gas. Lute the pipe J, fig. 1, to the mouth of the fuction-pipe at I; paſs the ſyphon L under the jar, as may be obſerved in fig. 5, and then extend the bellows. The bellows will become filled with the air of the jar; and this being diſcharged into that compartment of the caſk which is over the open ſide of the hood, the bellows will be ready for another extenſion; the repetition of which would ſoon exhauſt the jar of its air, although it ſhould be of the largeſt ſize.

This method of filling the machine is very convenient in a laboratory well ſupplied with pneumato-chemical apparatus. But it is a principal convenience of the hydroſtatic blow-pipe, that it may be filled with any gas, immediately from the retort, bottle, or matraſs, made uſe of in obtaining it. Let D, fig. 6, be a ſeparate repreſentation of the pipe D, fig. 1. Let B be a matraſs containing the ſubſtance from which the air is to be obtained, and let C be a ſyphon luted to the neck of the matraſs. The air iſſuing from the matraſs muſt be emitted from the mouth of the ſyphon at the lower end of the pipe D. Suppoſe that this pipe were in its proper ſituation at D, fig. 1, the air iſſuing from the matraſs would be diſcharged

diſcharged into that compartment of the caſk under which the mouth of the ſyphon ſhould be placed, and if the cock at Y ſhould be cloſed, this compartment alone would become filled; but if this cock ſhould be open, the air would divide itſelf equally between both compartments. It muſt be obvious, that while one matraſs and ſyphon are employed in filling one compartment with one ſpecies of air, the bellows, or another matraſs and ſyphon filled with different ſubſtances, may be employed in filling the other compartment with another ſpecies of air; and thus the oxygen, and hydrogen gaſes or oxygen gas, and atmoſpheric air, may at the ſame time be confined in the ſame veſſel without their mixing with each other.

Thoſe who deſire to experiment largely with oxygen gas will find it advantageous to make uſe of a caſt iron matraſs, with a ſhort and large neck narrowing inwards, and about fifteen inches of a gun barrel. The neck of the matraſs being made large and ſhort, it will not only be eaſily filled, but will be readily freed from any caput mortuum which may be left in it. The gun-barrel muſt be ground to fit the neck of the matraſs.

The ſyphon for conveying the gas into the caſk may be fitted to the gun-barrel with a cork.

The philoſophical world has been for ſome time acquainted with the intenſe heat produced by combuſtion ſupported with oxygen gas. By means of the hydroſtatic blow-pipe, every artiſt may, with little trouble and expenſe, avail himſelf of the intenſe heat produced by this combuſtion *.

Probably there are not at preſent many operations in the arts which require greater heat than may be produced by the ordinary means; but it is certain that the knowledge of a proceſs cannot precede an acquaintance with the heat neceſſary to effect it; and this moſt intenſe fire being placed within the reach of the artiſt, it is highly probable that caſes may be diſcovered in which it may be applied with convenience and utility.

The moſt convenient way of making uſe of oxygen gas for ſmall operations, is to ſupply one of the compartments of the hydroſtatic blow-pipe with that gas; to retain the gas thus confined for thoſe moments when the greateſt heat is required; and, by means of the other compartment, to make

* In a former page I mentioned the gaſometer of Lavoiſier as being too complicated for ordinary application to the ſupply of oxygen gas. I ſhould alſo have noticed the apparatus of Sadler and the gaſometer of Seguin; but, if I am not miſtaken, theſe, although very ingenious inventions, are liable to the ſame objection.

uſe of atmoſpheric air when the heat produced by it is ſufficiently intenſe. It muſt be obvious, if the conical mouths, O, o, of the pipes M, N, O, m, n, o, fig. 1, be furniſhed with ſtraight mouth-pieces, that any lamp or candle placed on the ſtand T V may be readily ſhifted from one mouth piece to the other, when it ſhall be deſired to expoſe any ſubject ſucceſſively to the heat produced by atmoſpheric air and oxygen gas.

If it be wiſhed to make uſe of the heat produced in the combuſtion of charcoal with oxygen gas; after having confined a ſufficient quantity of this gas, it will be neceſſary to fix in the conical mouth of the pipe, communicating with the compartment containing the gas, the larger end of a common braſs blow-pipe, the oriſice being directed downwards. Under this oriſice the body to be acted on muſt be placed, ſupported by a piece of charcoal, in the form of a parallelopiped, the charcoal being ignited in the part contiguous to the body. Things being thus arranged, by turning more or leſs the cock of the pipe in which the blow-pipe ſhall be fixed, a ſtream of oxygen may be precipitated on the burning ſpot, with the proper degree of rapidity *.

This method of ſupporting the combuſtion of carbon with oxygen gas is nearly the ſame as that by which the celebrated Lavoiſier performed his experiments; excepting that in the place of the hydroſtatic blow-pipe he made uſe of his gaſometer.

In the introduction to this paper it was mentioned that ſome experiments had been performed which ſeemed to invalidate the opinion that the employment of larger quantities of oxygen gas would be the only means of increaſing the power of caloric. I ſhall proceed to give an account of theſe experiments, but will firſt retrace the ideas which led to them.

In operating with the combuſtion of carbon and oxygen gas, great evils were obſerved to reſult from the difficulty of placing the ſubject of the operation in the focus of the heat, without interrupting the ſtream of air by which this heat was ſupported. Not only was the focus widened by this interruption, and the intenſeneſs of the heat thereby leſſened; but the ſtream of air oxidated thoſe ſubſtances which were combuſtible, and cooled thoſe which were otherwiſe, in the places where it impinged previouſly to its union with the charcoal.

* In detailing the uſes of the hydroſtatic blow-pipe, it may be proper to mention the facility which it gives to the employment of the gaſes for medical purpoſes. When this machine is filled with any gas, the bag to be made uſe of in reſpiring it may be inflated by fixing it to the mouth of the pipe of delivery communicating with the gas.

Added

Added to this, the charcoal was so rapidly consumed, that the substance acted on became so much buried, that it was difficult to follow it with the eye, or the orifice of the pipe: and some substances were observed to run into the pores of the coal, and elude examination.

To avoid these evils, it was thought desirable that means might be discovered of clothing the upper surface of any body which might be subjected to this species of operation with some burning matter, of which the heat might be equal to that of the incandescent carbon, with which the lower surface might be in contact; or by which bodies might be exposed on solid supports to a temperature equal or superior to that of the porous charcoal uniting with oxygen.

It soon occurred that these desiderata might be attained by means of flame supported by the hydrogen and oxygen gases; for it was conceived that, according to the admirable theory of the French chemists, more caloric ought to be extricated by this than by any other combustion.

By the union of the bases of the hydrogen and oxygen gases, not only is all the caloric of the oxygen gas evolved, but also a much larger quantity, which must be necessary to give the particles of the hydrogen their superior power of repulsion. The product of this combustion is water in the state of steam, which retains heat so slightly, that it acts merely as a vehicle to deliver it to other bodies. What is necessary to preserve to water its form of fluidity, is the only portion of the caloric extricated in this combustion, which is permanently abstracted.

The combustion of carbon with oxygen gas has been hitherto considered as the hottest of all fires. The caloric evolved in this case proceeds from the oxygen gas alone, while the product of this combustion is carbonic acid gas, which abstracts the large quantity of caloric, necessary to give it the form of permanent air, but which adds nothing to the heat of the combustion. Hence it is evident, that more caloric is evolved, and less abstracted, in combustion supported by the hydrogen and oxygen gases, than in that supported by oxygen gas and carbon.

However, the intenseness of the heat of combustion is not only dependent on the quantity of caloric extricated, but also on the comparative smallness of the time and space in which the extrication is accomplished. But in this respect the aëriform combustible has obviously the advantage over those which are solid, as its fluid and elastic properties render it susceptible of being rapidly precipitated into the focus of combustion,

combuſtion, and of the moſt ſpeedy mixture with the oxidating principle when arrived there.

The opinion of the intenſeneſs of the heat produced by the hydrogen and oxygen gaſes thus upheld by theory, derives additional ſupport from the practical obſervation of the great heat of a flame ſupported by hydrogen gas while iſſuing from a pipe; and alſo of the violent exploſion which takes place when it is mixed with oxygen gas and ignited; for it appears that this exploſion can only be attributed to the combination of an immenſe quantity of caloric with the water which is either held in ſolution by theſe gaſes, or formed by the union of their baſes.

Such was the reaſoning which originated the deſire of employing the flame of the hydrogen and oxygen gaſes. But before this could be accompliſhed it was neceſſary to overcome the difficulty of igniting a mixture of theſe aëriform ſubſtances without the danger of an exploſion. It was for the purpoſe of ſurmounting this difficulty that the hydroſtatic blow-pipe was furniſhed with two compartments, by means of which the machine might be at the ſame time charged with different ſpecies of air, without any poſſibility of mixture. One of theſe compartments being ſupplied with oxygen and the other with hydrogen gas, two common braſs blow-pipes a, b, fig. 8, were joined at their orifices to two tubular holes in the conical fruſtum of pure ſilver c, of which the mean diameter is one-third, and the length is three-fourths of an inch. The diameter of one of theſe holes is large enough for the admiſſion of a common braſs pin. The other hole is a third leſs. They commence ſeparately on the upper ſurface of the ſilver fruſtum near the circumference, and converge ſo as to meet in a point at the diſtance of a line and a half from the lower ſurface. In the ſpace between the lower ſurface and the point of meeting, there is a perforation of the ſame diameter as the larger hole. The manner in which this perforation and the tubular holes communicate one with the other, may be underſtood from the lines in the form of the letter Y, in the tranſparent repreſentation of the ſilver conical fruſtum at d. The pipes a b were then fitted into the mouths O, *o*, of the pipes of delivery, fig. 1; ſo that the blow-pipe inſerted into the larger hole of the fruſtum ſhould communicate with the compartment containing the hydrogen gas, and that the other ſhould communicate with that which contained the oxygen gas. The cock of the pipe communicating with the hydrogen gas was then turned until as much was emitted from the orifice of the cylinder

as

as when lighted formed a flame ſmaller in ſize than that of a candle. Under this flame was placed the body to be acted on, ſupported either by charcoal or by ſome more ſolid and incombuſtible ſubſtance. The cock retaining the oxygen gas was then turned, until the light and heat appeared to have attained the greateſt intenſity. When this took place, the eyes could ſcarcely ſuſtain the one, nor could the moſt refractory ſubſtances reſiſt the other.

However, it is worthy of notice that the light and heat of this combuſtion do not become evident until ſome body is expoſed to it, from which the light may be reflected, or on which the effect of the heat may be viſible. This is not the caſe with combuſtion ſupported by oxygen and carbon; for no ſooner is a ſtream of oxygen gas directed on ignited carbon, than an effulgence is produced, which impreſſes the mind of the beholder with an idea of the greateſt heat being produced by it.

It is in this different appearance of theſe different ſpecies of combuſtion that we may diſcover the reaſon why philoſophers have neglected the one, while they have beſtowed much attention on the other *.

In lieu of the conical fruſtum repreſented at c d, that at d e may be uſed. The tubular holes of this laſt-mentioned fruſtum do not meet, but deliver their air, at ſeparate orifices, into an excavation in the lower part of the fruſtum. The dotted lines repreſent the tubular holes, and the arched line the excavation. This is about three lines in diameter, and enters into the ſilver about the ſame diſtance.

At f are repreſented pipes which are uſed for the fuſion of platina, or ſubjects of the larger kind. They conſiſt of a large and a ſmall pipe, the oriſice of the one being inſerted into that of the other, as may be underſtood from the dotted lines near f.

The purity of gaſes contained in the hydroſtatic blow-pipe may be at any time examined by charging eudiometers from the ſyphon and leathern pipes hanging to the cocks Z Z. fig. 1. Theſe cocks are ſoldered to curved pipes, one of which is repreſented in the figure. By turning the cocks round, the

* The inferiority of the light emitted by the flame of the hydrogen and oxygen gaſes, to that which irradiates from bodies expoſed to its action, adds one to the many inſtances in combuſtion in which the quantity and colour of the light extricated do not ſeem to be ſo much dependent on the quantity of oxygen gas conſumed, as on the nature of the ſubſtances heated or burned. In this, therefore, we may find ſupport for the idea, that the light extricated by fire, or emitted by heated bodies, proceeds not only from the decompoſition of pure air, but from that of the combuſtible, or the heated bodies themſelves.

mouths

mouths of the curved pipes may be brought down to the furface of the water; this gives a facility to the difcovery of any heavier gas which may be mixed with one which is more light, as the fluid, whofe fpecific gravity is greater, will be found on the furface of the water.

I fhall now defcribe the changes effected on the moft fixed and refractory fubftances by the flame of the hydrogen and oxygen gafes.

In order to avoid a tedious recurrence to an awkward phrafe, I fhall generally, in the fubfequent part of this paper, diftinguifh the flame of the hydrogen and oxygen gafes by the appellation of *gafeous flame*.

By expofure to the gafeous flame, either on fupports of filver or of carbon, barytes, alumine, and filex, were completely fufed.

The products of the fufion of alumine and filex were fubftances very fimilar to each other, and much refembling white enamel.

The refult of the fufion of barytes was a fubftance of an afh-coloured caft, which after long expofure fometimes exhibited brilliant yellow fpecks. If it be certain that barytes is an earth, thefe fpecks muft have been difcoloured particles of the filver fupport, or of the pipes from which the flame iffued.

Lime and magnefia are extremely difficult to fufe, not only becaufe they are the moft refractory fubftances in nature, but from the difficulty of preventing them from being blown on one fide by the flame: nevertheleſs, in fome inftances by expofure on carbon to the gafeous flame, fmall portions of thefe earths were converted into black vitreous maffes. Poffibly the black colour of thefe products of fufion may have been caufed by iron contained in the coal; for in the high temperature of the gafeous flame, a powerful attraction is reciprocally exerted by iron and the earths.

Platina was fufed, by expofure on carbon, to the combuftion of hydrogen gas and atmofpheric air. But the fufion of this metal was rapidly accomplifhed by the gafeous flame, either when expofed to it on carbon or upon metallic fupports.

A fmall quantity of this metal in its native granular form, being ftrewed in a filver fpoon, and paffed under the gafeous flame, the track of the flame became marked by the conglutination of the metal; and, when the heat was for fome time continued on a fmall fpace, a lump of fufed platina became immediately formed.

About two penny-weights of the native grains of platina, when

when ſubjected to the gaſeous flame on carbon, became quickly fuſed into an oblate ſpheroid as fluid as mercury. This ſpheroid, after being cooled, was expoſed as before. It became fluid in leſs than the fourth of a minute.

Had I ſufficient confidence in my own judgment, I ſhould declare, that gold, ſilver, and platina, were thrown into a ſtate of ebullition by expoſure on carbon to the gaſeous flame; for the pieces of charcoal on which they were expoſed became waſhed or gilt with detached particles of metal in the parts adjoining the ſpots where the expoſure took place. Some of the particles of the metal thus detached exhibited ſymptoms of oxidation.

As the fuſion of lime and magneſia by expoſure on carbon was accompliſhed with great difficulty and uncertainty, it became deſirable that means might be diſcovered of effecting this fuſion with greater eaſe.

By the union of the baſe of oxygen with iron, the whole of the caloric of this elaſtic fluid is ſuppoſed to be extricated. This conſideration, together with ſome practical remarks on the heat of burning iron, induced me to employ the combuſtion of this metal in conjunction with that of the hydrogen and oxygen gaſes.

Some pieces of iron wire, each of about half an inch in length, were quickly thrown into fuſion and rapid combuſtion by expoſure on carbon to the gaſeous flame. When either lime, magneſia, barytes, alumine, or ſilex, were thrown on the iron in this ſtate, they became inſtantly melted and incorporated with the metal. It remains a queſtion whether in this caſe the earths were fuſed or diſſolved, and whether the ſubſtances which reſulted from their union with the iron were mixtures or combinations. If they were combinations, according to the preſent nomenclature, they ſhould be denominated *ferrurets*.

The difficulty of igniting ſome ſubſtances which are only ſuſceptible of combuſtion at very high degrees of heat, has hitherto excluded them from the laboratory. By means of the gaſeous flame, ſuch ſubſtances may be employed with the greateſt facility in ſmall analytical operations.

Of the nature of the ſubſtances above deſcribed are the carburets of iron and ſome peculiar ſpecies of native coal.

Among the carburets of iron, the Engliſh plumbago is eſteemed the beſt. Some pieces of this ſubſtance, obtained from the beſt Engliſh black-lead pencils, were readily thrown into combuſtion by expoſure to the gaſeous flame, either on carbon or on ſome larger pieces of American plumbago. It was found that either lime or magneſia was fuſible when

expoſed to the fire thus produced. This, however, may have been cauſed by the iron contained in the carburet; for the fuſed earths and plumbago generally adhered to each other.

There is a peculiar ſpecies of native coal found on the banks of the Lehigh in this ſtate, which it is extremely difficult to ignite; but when expoſed to a high degree of heat, and a copious blaſt of air, it burns, yielding an intenſe heat without either ſmoke or flame, and leaving little reſidue. By expoſure to the gaſeous flame on this coal, both magneſia and lime exhibited ſtrong ſymptoms of fuſion. The former aſſumed a glazed and ſomewhat globular appearance. The latter became converted into a browniſh ſemivitreous maſs.

The heat of the gaſeous flame is very much dependent on the proportional quantities of the gaſes emitted. On this account, the perforations in the keys of the cocks N, n, fig. 1ſt, ſhould be narrow and oblong, to admit of a more gradual increaſe or diminution in the quantity of gas emitted.

I have now concluded my communications on the ſubject of this paper, and ſhall be happy if they have been found worthy of the time and attention beſtowed on them by the ſociety.

XLVIII. *On the double Refraction of Rock Cryſtal, and another dioptric Property of that Mineral Subſtance.* By C. P. Torelli de Narci, *attached to the Council of Mines* *.

DOUBLE refraction, that ſingular property of rock cryſtal †, and of ſeveral other minerals, has long engaged the attention of mineralogiſts and philoſophers, though they employed it in no other manner than as a diſtinguiſhing character. C. Haüy ſays ‡: "It would be difficult to find a more ſtriking character than that deduced from double refraction, ſince it depends on the eſſence of the minerals in which it exiſts."

C. Rochon is the firſt philoſopher who employed this property of rock cryſtal to meaſure ſmall angles; and he read on the 26th of January and 9th of April 1777, to the Academy of Sciences, two memoirs on the application he made of it, and the exact reſults he obtained. This diſcovery muſt be of the greateſt utility, if means ſhould be found to conſtruct the inſtrument he invented at ſo moderate a price as to bring

* From the *Journal des Mines*, No. 66.

† Limpid hyalin quartz. Haüy *Traité de Mineralogie*, vol. ii. p. 427.

‡ Vol. i. of his Treatiſe, p. 254.

it

it within the reach of thoſe who might have occaſion to meaſure angles with it.

A deſire to accompliſh this object induced me to undertake ſome reſearches in regard to the cutting of rock cryſtal, and experiments on its double refraction, founded on thoſe made by Beccaria and Rochon. With rock cryſtal alone I formed *mediums doubly* refringent. This is the name which Rochon gives to theſe inſtruments cut cylindrically and compoſed of two or three priſms of this ſubſtance, which are perfectly achromatic, and produce very ſtrong double refraction. I conſtructed one with three priſms, in which the angle of double refraction is one degree eight minutes: and I find that larger may ſtill be obtained.

I ſhall not here indicate the direction in which I cut my different priſms of rock cryſtal in order to obtain the *maximum* of double refraction, becauſe I have ſtill ſome experiments to terminate before I can acquire a thorough knowledge of them. Among thoſe which I cut for my experiments, there is one which produces effects ſo ſingular that I think it my duty to deſcribe it.

This priſm, the ſection of which is an iſoſceles triangle, has one of its angles obtuſe, and of more than 100 degrees. When one looks through the two faces which form the obtuſe angle, and in a direction parallel to the face oppoſite to it, the object appears neither diſplaced nor ſenſibly coloured, but only inverted in ſuch a manner, that what is on the right appears on the left; and *vice verſa*. If a capital L, for example, cut out and applied to the pane of a window, be looked at, the horizontal line of that letter, inſtead of being on the right below the vertical one, appears to be ſituated on the left. By continuing to look at this letter, if the priſm be turned on itſelf, and in ſuch a manner as if it were traverſed by an axis parallel to the direction in which the letter is viewed, the image of the letter turns at the ſame time as the priſm; but it moves twice as quick—ſo that, if the priſm makes one turn, the image of the letter makes two. I made other very ſingular experiments with this priſm; but as it would be too tedious to detail them here, I ſhall reſerve them for a memoir, in which I ſhall explain the means I employed to aſcertain the rules which muſt be followed to cut rock cryſtal in the direction that produces the *maximum* of its double refraction, and to be able to conſtruct, without repeated trials, the inſtrument invented by Rochon, to meaſure, with very great preciſion, diſtances of every kind. I ſhall treat of its application to mines; and ſhall deſcribe the

method I purſued to meaſure the deepeſt wells and the longeſt galleries.

I ſhall conclude this note with a ſuccinct account of ſome experiments which I made with the iſoſceles priſm of rock cryſtal already mentioned. By applying it to a ſimple *camera obſcura*, the objects painted in an inverted poſition, when this priſm is not uſed, are made to appear in their proper ſituation. By adapting it to aſtronomical teleſcopes, the ſame effect will be produced in regard to objects, which, when ſeen through the two convex glaſſes that compoſe it, appear inverted.

This priſm ſupplies the means of ſhortening teleſcopes deſtined to view terreſtrial objects, becauſe, by employing it with a convex eye-glaſs only, and an object-glaſs ſimple or achromatic, inſtead of three, four, or five eye-glaſſes, objects which without its interpoſition would have appeared inverted, will be ſeen in their proper poſition. By theſe means, one, two, three, or even four eye-glaſſes would be ſaved, and the teleſcope might be ſhortened by nearly the whole length occupied by theſe eye-glaſſes. Light alſo will be gained; for this priſm occaſions no loſs in this reſpect, the matter of which it is formed being exceedingly tranſparent; nor will any thing be loſt in regard to diſtinctneſs; for, as the priſm is very near the eye, the faults which might ariſe from any inexactneſs in the poliſhing of its two ſurfaces will not be ſenſible.

In employing this teleſcope it muſt be remembered, that at the ſame time that it inverts objects by turning them upſide down, it turns them from right to left, and what appears on the right in the field of the teleſcope is really on the left: for example, if a man going from right to left be viewed with it, he will appear in the teleſcope as if going from left to right, but in his natural ſituation: whereas, if viewed with the ſame teleſcope, taking from it the priſm of rock cryſtal and leaving only the eye-glaſs which inverts the objects, the man would appear not only to be proceeding in a direction contrary to that in which he really is advancing, but he would appear alſo inverted—the common effect of teleſcopes which have only a convex eye glaſs.

Experience alone can ſhow whether this method of ſhortening land teleſcopes can be as uſeful as it appears curious, and whether it will be poſſible to conſtruct one at ſuch a moderate price as to maintain a competition with common teleſcopes, without which this inſtrument would remain among the number of thoſe diſcoveries which are rather curious than uſeful.

XLIX. *Pre-*

XLIX. *Preparation of the Phoſphuret of Lime.* By J. B. Van Mons *.

PHOSPHURET of lime affords to the amateurs of amuſing chemiſtry a curious compound, on account of the property it has of diſengaging, when a few bits of it are thrown into water, a quantity of gaſeous bubbles, which, on reaching the ſurface of that liquid, inflame ſpontaneouſly with a beautiful white flame, and give riſe to ſucceſſive detonations, which may be compared to a running fire of muſketry. But the preparation of this phoſphuret is often unattended with ſucceſs on account of the air, which, by following the uſual proceſs, cannot be excluded from the veſſels, and which oxidates and even acidifies the phoſphorus; in which caſe, the combuſtible loſing its action on the water, no detonating gas is engendered; and the correction, by which the inconvenience of oxidation is avoided, by putting the phoſphorus at the bottom of the veſſel, and the lime at the top, does not give a homogeneous product, but a ſaturated phoſphuret, by the vaporization of the phoſphuret, which brings it to a ſtate improper for uniting itſelf with the lime. Theſe different obſtacles may be avoided by proceeding in the following manner:

Fill a ſmall glaſs matraſs, with a flat bottom and a long narrow neck, two-thirds, with one part of carbonated lime (white marble, waſhed chalk, or prepared oyſter-ſhells). Place the matraſs in a ſand bath, and apply a heat capable of expelling the carbonic acid from the lime. When you think that the decarbonization is near an end, introduce in portions a third part of phoſphorus, at very ſmall intervals, and conſtantly maintaining the matter at a dark red heat. The phoſphorus fuſed, and prevented from burning by a remainder of carbonic acid gas which is diſengaged from the lime, diffuſes itſelf throughout the whole maſs of the matter, contracts an union with the lime, loſes its volatility, and forms phoſphuret. After the whole phoſphorus is introduced, let the fire be ſuddenly ſlackened, and ſtop the matraſs with a ſtopper having a pneumatic valve to prevent acceſs of the air, and to ſuffer to eſcape the gas which the matter that remains ſome time puffed up continues to diſengage. When the matter is ſufficiently cooled, take it from the matraſs, and put it, taking care not to touch it with the

* From *Journal de Chimie et de Phyſique, par* J. B. Van Mons. No. 7.

fingers or other moiſt bodies, into heated glaſs flaſks which can be hermetically cloſed.

The phoſphuret of lime, when well prepared, is a compact maſs of a pale reddiſh brown colour inclining to chocolate. It inflames by the leaſt humidity, and emits in the air an odour of garlic mixed with that of phoſphorated hydrogen gas.

The ſame phoſphuret may alſo be prepared directly from lime, by directing, by means of a gaſometer with a column of water, through a hole formed in the belly of the matraſs, on the red matter, at the moment of adding the phoſphorus, a delicate current of carbonic acid gas.

L. *Chemical Analyſis of an uncommon Species of Zeolite. By* Robert Kennedy, *M.D. F.R.S. F.A.S., and Member of the Royal College of Phyſicians, Edinburgh**.

THE zeolite ſubjected to the following experiments poſſeſſes ſome of the diſtinguiſhing properties common to other ſtones of the ſame claſs, but differs in certain reſpects from any variety with which I am acquainted. I found it, more than three years ago, in the baſaltic rock on which the caſtle of Edinburgh is built; and it was incloſed within a maſs of prehnite.

The colour of this zeolite is in ſome parts nearly white, in others grayiſh white. It is compoſed entirely of ſtraight fibres arranged in bundles or maſſes of different ſizes, all the fibres of each maſs converging towards a common point. The whole ſpecimen is an aggregate of theſe maſſes, the baſes of which are in contact with the prehnite, and are impreſſed with the form of its ſurface, which is rounded or botryoidal. The croſs fracture preſents the irregular and ragged ends of the broken fibres, termed the *hackly* fracture by Mr. Kirwan.

Although the ſhape and arrangement of the fibres appear plainly to be the effects of cryſtallization, yet I have not been able to trace a perfectly regular, determinate form in any of them. However, when the ſtone is broken, ſome of them can be readily ſeparated longitudinally, in a pretty entire ſtate, and ſeem in moſt inſtances to be four-ſided and rectangular. Their length is from half an inch to two inches; but their thickneſs does not exceed 1-45th or 1-50th part of an inch. None of theſe fibres can be broken acroſs, ſo as to

* From the Edinburgh Tranſactions, vol. v.

preſent

preſent an even ſurface: for they break irregularly, and become divided at the point of fracture into very minute ſpiculæ, which alſo aſſume a ſomewhat rectangular ſhape.

The ſmall ſpiculæ or fibres are tranſparent and colourleſs, with a conſiderable degree of luſtre; but the unbroken part of the ſtone poſſeſſes leſs luſtre than the ſeparate ſpiculæ, and much leſs tranſparency, from a want of compactneſs, and from the effect of many minute cracks.

Its hardneſs is not eaſily determined, on account of brittleneſs; but when a piece of it is rubbed againſt glaſs, though the fibres crumble down very quickly, yet the glaſs is ſlightly ſcratched at the ſame time. Small fragments of it can be broken with the fingers, or cruſhed by preſſure, into very ſlender ſpiculæ, which are ſharp, and apt to penetrate the hands when touched. Although the coheſion of its component parts be ſo weak, yet it bends, and yields in ſome meaſure before it breaks, and is not eaſily ground to powder in a mortar.

I found the ſpecific gravity of different pieces of the ſpecimen, taken in diſtilled water at the temperature of 60°, to vary from 2·643 to 2·740.

This ſtone has the property of appearing luminous in a dark place, both by friction and by heat. A very ſlight degree of friction produces this effect; for a perſon can eaſily diſtinguiſh a phoſphoric light, even if he draws his finger acroſs it. When ſtruck with a hammer in ſuch a manner that ſmall fragments are driven off, they appear luminous in paſſing through the air, and continue to ſhine for a moment after falling on the ground; and a hard body drawn over it leaves a track of light, which remains a ſecond or two viſible. When a piece of the ſtone is pounded quickly in a mortar, a ſtrong light is emitted; but after being wholly reduced to powder, it no longer ſhines.

The light which it gives by ſlight friction, is fully equal to that produced by two quartz pebbles rubbed or ſtruck againſt each other ſtrongly.

Small fragments of this zeolite placed on a piece of hot iron or of clay, alſo become luminous, and ſhine with nearly as much brightneſs as common blue fluor does, when heated in the ſame manner. By being made red-hot, however, it is deprived of the property of giving light afterwards by heat, though it ſtill appears faintly luminous by friction. In all theſe experiments it is a reddiſh white light which it emits, accompanied at times with reddiſh momentary kind of flaſhes.

It can be melted without difficulty into glaſs. When a

ſmall piece of it is heated gradually with the blow-pipe, it firſt becomes white and opaque; a number of fiſſures are then formed, by which its bulk appears ſomewhat increaſed; and after the flame is made ſufficiently intenſe, it melts into a globule of colourleſs glaſs, the tranſparency of which is imperfect on account of many minute air-bubbles. Although thus fuſible by ſtrong heat, yet a very low degree of ignition ſcarcely affects it. A piece of the ſtone, after having been put into a crucible, and expoſed for a ſhort time to a fire which made it juſt viſibly red-hot, was not altered in appearance, and had not loſt more than $\frac{1}{100}$th part of its weight. In a temperature, however, about 20° of Wedgwood, I found that a fragment of this zeolite became opaque, and more eaſy to pulverize than in its natural ſtate; at 90° it did not melt, but was glazed on the ſurface, adhered to the crucible, and had begun to ſink down; and at 120° melted into an imperfect glaſs of a light greeniſh yellow colour, deficient in tranſparency, which acted ſtrongly on the crucible.

In temperatures ſufficiently high, it loſes from $4\frac{1}{2}$ to 5 per cent. of its weight; but to produce this effect, the heat muſt be equal at leaſt to 20° or 25° of Wedgwood. Part of the volatile matter thus driven off, is carbonic acid; for the zeolite, when reduced to powder, and mixed with acids, produces a ſlight effervescence. I found, by three different experiments, that the loſs of weight after the effervescence was about 3 per cent.; conſequently, the remaining 2 or $2\frac{1}{2}$ parts may be preſumed to conſiſt of moiſture.

This ſubſtance produces a jelly, as moſt other zeolites do, with the ſtronger acids. When ground to powder, and mixed with the ſulphuric, nitric, or muriatic acid, the mixture becomes a firm jelly in a few minutes, provided the acids are not much diluted, or uſed in too great quantity. That which is formed by the action of the nitric or the muriatic acid, is nearly tranſparent; but the ſtone contains ſo much lime, as will preſently be ſhown, that with the ſulphuric the jelly is white and opaque, on account of the ſulphate of lime which is generated.

The prehnite in which it was incloſed, as already mentioned, is of a light green colour, with ſome luſtre, and a conſiderable degree of tranſparency. It gives fire with ſteel, can be readily melted with the blow-pipe, and froths up much before fuſion.

Having made theſe preliminary experiments reſpecting the general properties of the zeolite, I ſubjected a portion of it, in the next place, to analyſis, to aſcertain of what earths it was compoſed,

compoſed, and found that it conſiſted almoſt wholly of ſilex and lime, with a certain proportion of ſoda. The following were the methods by which it was analyſed:

1. One hundred grains, reduced to fine powder in a mortar of flint, were mixed with 500 grains of muriatic acid and 1000 grains of diſtilled water. The powder was immediately attacked by the acid; ſome heat and momentary effervescence were produced, and in a few minutes the ſilex appeared floating in a looſe and very divided ſtate. The mixture being heated on a ſand-bath, became in a ſhort time a thin tranſparent jelly. I expoſed this jelly to a gentle heat (leſs than 200° of Fahrenheit) till it became nearly dry. Water was then poured on it, and the mixture, after being digeſted for ſome time, was filtered. The undiſſolved part collected on the filter, when ſufficiently waſhed, was dried and heated red-hot for a quarter of an hour. It weighed 51½ grains, was perfectly white, and proved on examination to be pure ſilex, unmixed with any other earth.

2. The filtered ſolution, which was tranſparent and nearly colourleſs, after being ſaturated with cauſtic ammonia, depoſited a ſmall quantity of a browniſh white precipitate. Having collected this precipitate on a filter, and waſhed it, I expoſed it for a few minutes to a red heat. It then weighed one grain, and had become brown, and was found to conſiſt of half a grain of oxide of iron, and half a grain of argil.

3. In the next place I added a few drops of ſulphuric acid to the ſolution, to diſcover if it contained any barytes or ſtrontian. The acid produced no precipitate. The ſolution was then evaporated to a ſmall quantity, and boiled with carbonate of ammonia. Some carbonate of lime was thrown down, which, after being waſhed, and expoſed for a few minutes to a very low red heat, weighed 57 grains. To drive off the carbonic acid, and aſcertain the real quantity of lime which this precipitate contained, I put it into a ſmall crucible of Corniſh clay, which was incloſed within a Heſſian crucible, and heated it for three hours. The fire was raiſed ſlowly at firſt, but was afterwards increaſed to 80° of Wedgwood. The lime adhered ſlightly, and weighed 31½ grains. By treating it with ſulphuric acid I detected ſome ſlight traces of magneſia, the reſt being wholly converted into ſulphate of lime.

4. The different earths having been thus ſeparated from the ſolution, it was evaporated to dryneſs for the purpoſe of obtaining the ſoda, which I had learned by previous experiments would be wholly taken up with the other ſoluble parts of the zeolite, when decompoſed by acids. After the evaporation

poration a white ſalt remained, which was heated gradually in a crucible to volatilize the muriate of ammonia formed in the courſe of the analyſis. When white vapours ceaſed to riſe, the heat was increaſed to redneſs, and a ſalt was left which weighed 17 grains. On redilſolving it in a ſmall quantity of water, and boiling the ſolution with carbonate of ammonia, a minute portion of carbonate of lime was precipitated, which weighed one grain; equal to about half a grain of pure lime. I obtained the ſalt by a ſecond evaporation; and after it had been expoſed again to a very low red heat, it weighed 16 grains, and conſiſted wholly of muriate of ſoda.

According to Mr. Kirwan's experiments, 16 parts of muriate of ſoda in cryſtals contain 8·5 parts of ſoda; but the 16 parts above mentioned, by having been dried in a red heat, and conſequently freed from water of cryſtallization, would contain ſomewhat more than 8·5 parts of ſoda. However, the proportion of ſoda in 100 parts of the zeolite may be ſtated at 8·5 parts, which, though probably rather leſs than the real quantity, muſt be very nearly correct.

Having finiſhed the experiments juſt deſcribed, I analyſed the zeolite a ſecond time; and made uſe of nitric acid, for the purpoſe of aſcertaining whether any muriatic acid entered into its compoſition. By the teſt of nitrate of ſilver, I found that ſome traces of the muriatic acid could be diſtinguiſhed, although the quantity was very ſmall. With regard to the proportion of the earths, the reſults of the ſecond analyſis correſponded almoſt exactly with the former.

I alſo expoſed ſome of the zeolite to the action of the ſulphuric acid in the following manner, with the view of obtaining the ſoda only, the earths being diſregarded. One hundred grains*, reduced to fine powder in the flint mortar, were mixed with 250 grains of ſulphuric acid, diluted with twice its weight of water. Some heat and very ſlight effervescence were produced, and the mixture ſoon became thick and gelatinous. It was then evaporated ſlowly to dryneſs in a ſand-bath in a cup of Chineſe porcelain; and the dry maſs was pulverized and boiled for half an hour with water, and filtered. Having waſhed the undiſſolved reſiduum ſufficiently, I boiled the filtered ſolution with carbonate of ammonia, which precipitated ſome earthy matter. After this had been ſeparated by filtration, the ſolution was evaporated to dryneſs

* I made uſe of ſmall quantities only of the zeolite in all theſe experiments; becauſe, as the ſpecimen appears to be the only one of the kind which has been found, I wiſhed to preſerve as much of it entire as poſſible.

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by a gentle heat; and the ſaline maſs left was put into a crucible, and heated ſlowly to redneſs. A white ſalt remained in the crucible, which weighed 19 grains. To free this ſalt from any remains of earthy ſalts which might be mixed with it, I diſſolved it in a ſmall quantity of water, added ſome carbonate of ammonia, and boiled the mixture for a few minutes, by which means a ſlight earthy precipitate was thrown down. This being ſeparated as before, the ſalt was again collected by evaporation, and heated to redneſs. It now weighed 17¾ grains, and was found on examination to be pure ſulphate of ſoda *.

By Mr. Kirwan's eſtimation, 17¾ parts of dry ſulphate of ſoda contain nearly eight parts of alkali; conſequently, from 100 parts of the zeolite there have been obtained by the proceſs laſt deſcribed eight parts of ſoda. This reſult correſponds with the former, in which the alkali was collected in the ſtate of muriate of ſoda, as nearly as can be expected in ſuch experiments; and it muſt be remembered, that the proportions of the component parts of neutral ſalts are not aſcertained with preciſion.

According to the different experiments now detailed, 100 parts of this zeolite contain,

Silex (No. 1.) - - -	51·5
Lime (No. 3 and 4.) - -	32
Argil (No. 2.) - - -	·5
Oxide of iron (No. 2.) - -	·5
Soda, about - - - -	8·5
Carbonic acid and other volatile matter	5·
	98·

with ſome traces of magneſia and muriatic acid.

The ſtone which has now been deſcribed reſembles ſome of the varieties of tremolite mentioned by Sauſſure †, in the property of giving a phoſphoric light by friction. Its ſpecific gravity alſo is ſomewhat greater than that of the ordinary kinds of zeolite, as ſtated by mineralogiſts. Excepting in theſe particulars, however, it has the principal characters of

* The experiments which ſhowed that ſoda was the alkaline baſis of this ſalt, have not been ſtated here; becauſe I formerly gave a deſcription of the methods uſed in examining the ſame ſalt, in the paper on whinſtone and lava, publiſhed in part 1. vol. v. Edinb. Tranſac. To avoid unneceſſary repetition, I beg leave to refer to that paper, both with regard to the manner in which I endeavoured to determine the purity of the ſaline matter, and alſo that of the ſilex and ſome other earths.

† Voyages dans les Alpes, §923.

a zeolite;

a zeolite; for example, in its internal composition, in having been found in a whin rock adhering to prehnite, and in producing a jelly with acids. Tremolites have a higher specific gravity than this stone, are more infusible, and are considerably different in their composition *. Besides, such kinds of tremolite as I have examined cannot be decomposed by acids even when boiling, and must be heated with potash or soda before their component parts can be separated; but the substance in question is completely decomposed by acids, like the greater number of zeolites, in a very few minutes, and without the assistance of heat. For these reasons it appears to me to be a zeolite.

LI. *Experiments respecting the Action of some lately discovered Metals and Earths on the Colouring Matter of Cochineal.* *By* M. Hermstaedt †.

To prepare the cochineal for these experiments, two ounces of Mexican cochineal of the first quality, being reduced to fine powder, were boiled in a tin bason with 74 ounces of distilled water. The liquor was then filtered and measured: it had lost two ounces by evaporation. It was then divided into portions of 2½ ounces for each experiment.

A piece of kerseymere dipped in this tincture when taken out was of a lilac colour.

Exp. I. A saturated solution of very pure cobalt in nitric acid was dropped into a portion of the tincture of cochineal. The tincture became very clear, assumed a yellowish red colour, but remained diaphanous. After twelve hours there was deposited a precipitate of a sulphur-red colour; which, however, was in such small quantity that it was impossible to collect it.

Exp. II. Part of the solution of cobalt in nitric acid was diluted with water heated to ebullition in a glass vessel, and kept boiling for three minutes, with a piece of kerseymere 24 inches square. The kerseymere thus prepared being then immersed in the warm tincture of cochineal, immediately assumed a saturated bright red colour, leaving the tincture

* Kirwan's Mineralogy, vol. i. p. 278. Traité de Mineralogie par Haüy, tome iii. p. 151 and 227.

† From Scherer's *Allgemeines Journal der Chimie*, January 1802.

colourless.

colourleſs. The ſtuff, after it was waſhed and dried, retained a bright *mordoré* colour.

Exp. III. A neutral ſolution of cobalt in ſulphuric acid was added to the tincture of cochineal. The tincture aſſumed a darker colour, and a violet precipitate was depoſited. A piece of ſtuff impregnated with this ſolution of cobalt, and then dipped in tincture of cochineal, acquired a ſaturated violet colour.

Exp. IV. A neutral ſulphuric ſolution of uranium gave with tincture of cochineal a precipitate almoſt black; but when a piece of ſtuff was dipped in the ſame ſolution, and then dyed with tincture of cochineal, it aſſumed a very agreeable graviſh colour inclining to green.

Exp. V. A ſolution of cobalt in nitric acid, treated in the ſame manner, gave the ſame reſults; but with this difference, that the colour on the ſtuff was a little brighter.

Exp. VI. Fifteen grains of tungſtic acid were put into a glaſs veſſel, and ſix ounces of diſtilled water being poured over it, the whole was reduced by evaporation to four ounces. The ſolution aſſumed a turbid aſpect, and a blueiſh white colour. A part of this ſolution being poured into tincture of cochineal, communicated to it a bright violet colour. A piece of kerſeymere, being boiled for three minutes in this ſolution, was immerſed in the warm tincture of cochineal: when taken out it was of a bright *ponceau* (poppy) colour.

Exp. VII. Fifteen grains of concrete molybdic acid were diſſolved in water as above. It diſſolved entirely, and the ſolution became clear and tranſparent. Being dropped into the tincture of cochineal, a dark violet precipitate was obtained. A piece of kerſeymere boiled in the acid ſolution aſſumed a colour approaching to bright green, which, when the ſtuff was dried in the ſun, paſſed to a gray inclining to bright blue. A piece of kerſeymere impregnated with the ſame ſolution, being immerſed in warm tincture of cochineal, aſſumed a very agreeable violet colour.

Exp. VIII. Arſenic acid, being mixed with the tincture of cochineal, the dark red colour of the latter was transformed into yellowiſh red, but without any depoſit being formed. A piece of kerſeymere was then boiled for three minutes in a very dilute ſolution of the ſame acid, and the ſtuff thus prepared was immerſed in warm tincture of cochineal. The ſtuff immediately aſſumed a bright ſcarlet colour inclining ſtrongly to yellow. Drying, and, in particular, preſſing with a hot iron, made this colour loſe a little of its brightneſs, and cauſed it to become darker.

Exp. IX. A solution of arseniate of soda slightly acidulated was applied as a mordant to another piece of kerseymere, and by immersion in tincture of cochineal a dark *mordoré* colour was obtained.

Exp. X. The same was repeated with alkaline arseniate of soda: an agreeable lilac was obtained.

Exp. XI. Common white arsenic dissolved in water, gave a lilac colour somewhat dark.

Though the author intended only to try the action of the metals lately discovered on the colouring matter of cochineal, results before obtained from lead induced him to subject this metal also to some new trials. He undertook at the same time to ascertain how far the use of nitrate of tin is indispensably necessary in dyeing common scarlet, by endeavouring to substitute for that salt muriate of the same metal. These researches gave rise to the following experiments:

Exp. XII. A solution of acetite of lead being poured into tincture of cochineal, a violet blue precipitate was formed. A piece of kerseymere prepared with acetite of lead was then immersed in the same tincture, and a very agreeable violet colour was obtained.

Exp. XIII. A solution of fine English tin in pure muriatic acid was exposed for four weeks in an open vessel to the action of the air. A piece of kerseymere being boiled in this solution, and then immersed in warm tincture of cochineal, it assumed a bright scarlet colour.

This result is the more remarkable, as it has hitherto been believed that it was impossible to dye scarlet without a solution of tin in aqua-regia; and indeed the red obtained by employing common muriate of tin inclines to violet. It appears, therefore, that the oxygen of the nitric acid brightens the colour. As the same state of oxidation may be communicated to muriate of tin by exposure to the air as by nitric acid, the expense occasioned by the use of this acid and that of sal-ammoniac may be spared by substituting muriatic acid, which is much cheaper.

Exp. XIV. A piece of kerseymere was boiled for three minutes in a neutral solution of muriate of barytes, and then immersed in tincture of cochineal. The stuff assumed a dark colour, which, after being washed and dried, changed to an agreeable violet.

Exp. XV. Nitrate of barytes employed as a mordant gave a ponceau red exceedingly agreeable.

Exp. XVI. Acetite of barytes tried for the same purpose, gave

gave a dark red ponceau; which, however, poſſeſſed great brightneſs.

Exp. XVII. A piece of kerſeymere was dipped for three minutes in a ſolution of muriate of ſtrontian, and then immerſed in a bath of cochineal. It aſſumed a dark colour; which at firſt imitated that of ſcarlet, but which by drying paſſed to crimſon.

Exp. XVIII. A neutral ſolution of nitrate of ſtrontian produced a bright reddiſh brown.

Exp. XIX. Acetite of ſtrontian produced a bright *ponceau*.

The reſults of theſe experiments prove, not only that the metals and earths ſubjected to trial poſſeſs a certain chemical affinity for the colouring matter of cochineal, and are capable of fixing it on ſtuffs, but that they poſſeſs alſo the property of producing with the ſame pigment very different ſhades. They prove beſides, that the nature of the acid, which ſerves as a ſolvent to theſe ſubſtances, exerciſes a great influence on the ſhades produced.

The reſults obtained with the oxide of arſenic and the acid of that metal, are no leſs worthy of attention. The difference of the colours produced is particularly remarkable. The oxygen, no doubt, had the greateſt ſhare in this phænomenon, as this principle manifeſts, in a very evident manner, its great influence in the production of ſcarlet by the muriate of tin oxidated by the air.

LII. *On the Manner of Hunting and Sporting by the Engliſh in Bengal. Communicated by Colonel* G. Ironside *.

FEW parties of pleaſure can be more agreeable than thoſe for hunting, formed by ladies and gentlemen in Bengal, particularly at ſome diſtance from the preſidency of Fort William, where the country is pleaſanter, and game of every kind in greater plenty. Any time between the beginning of November and end of February is taken for theſe excurſions; during which ſeaſon the climate is delightfully temperate, the air perfectly ſerene, and the ſky often without a cloud.

To tranſport the tents and other requiſites, for the accom-

* From the *Aſiatic Annual Regiſter for* 1801.

modation of the company, to ſome verdant ſpot, near to a grove and rivulet, previouſly ſelected, elephants and camels are borrowed; ſmall country carts, oxen, and bearers hired, at no conſiderable expenſe, the price of all kinds of grain, and wages of courſe, being exceedingly reaſonable. Nor does the commanding officer of the troops within the diſtrict often refuſe a guard of ſepoys to protect the company from the danger of wild beaſts, (for ſuch generally reſort to the haunts of game,) or the depredations of ſtill wilder banditti, now and then pervading the country.

The larger tents are pitched in a ſquare or circle, while thoſe for the guards and ſervants uſually occupy the outer ſpace. Every marquée for a lady is divided into two or three apartments, for her camp-bed, her cloſet, and her dreſſing-room; is carpeted or matted, and is covered with a ſpreading fly, for defence againſt rain, or excluſion of caſual heat, the air ventilating powerfully between the vacuity (about two feet) of the tent and its canopy in unremitted undulation. The doors or curtains of the marquée, wattled with a ſweet-ſcented graſs, are, if the weather chance to become ſultry, continually ſprinkled with water from the outſide; and a chintz wall, ſtained in handſomely-figured compartments, encompaſſes the whole.

For the ſupply of common food, if no village be very near, petty chandler ſhops enow are engaged by the family banyans (houſe ſtewards) to accompany them, glad to profit of ſuch an opportunity of gain. Liquors and every ſpecies of European articles are provided by the party themſelves.

Horſes are employed for the conveyance of the gentlemen, and palanquins for the ladies, with their female attendants; and, where the roads will admit of it, cloſe and open Engliſh carriages alſo.

Part of the morning ſports of the men, commencing at dawn of day, conſiſt in rouſing and chaſing the wild boar, the wolf, and antelope (or gazelle), the roebuck, the muſk, the red and other deer, hares, foxes, and jackalls: beſides the common red, the ſpotted and the ſmall mooſe, there are ten or twelve ſorts of hog or ſhort-briſtled deer. Boars are uſually found amongſt the uncultivated tracts, or the more regular plantations of ſugar-canes, which give to their fleſh the fineſt flavour imaginable. Wolves and jackalls are ſeen prowling and lurking, at break of day, about the ſkirts of towns and villages, or retiring from thence to their dens within woods; or within pits, hollows, or ravines, on the downs. Hares ſhelter in the ſame ſituations as in England.

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The hog, roebuck, and muſk deer, conceal themſelves amongſt the thickeſt heath and herbage, and the antelope and large deer rove on the plains. All theſe animals, however, reſort not rarely to the jungles (or very high coarſe and implicated graſs), with which the levels of Hindoſtan abound, either to graze, to browſe, or in purſuit of prey.

A country of Aſia abounding in ſuch variety of game, is, of courſe, not deſtitute of wild beaſts; the principal of which are the tiger, leopard, panther, tiger cats, bear, wolf, jackall, fox, hyæna, and rhinoceros. The leopards are of three or four kinds.

Or the gentlemen divert themſelves with ſhooting the ſame animals; as alſo common partridge, rock partridge, hurriâl or green pigeons, quail, plover, wild cocks and hens, curlews; black, white, and gray peacocks; florikens, ſtorks of ſeveral kinds and colours, together with water hens, Braminy geeſe, cranes, wild geeſe and ducks, teal, widgeons, ſnipes, and other aquatic fowl, in infinite abundance; many of them of extraordinary ſhape, of glowing variegated plumage, and of unknown ſpecies; whoſe numbers almoſt cover the water whilſt they ſwim, and, when alarmed, and flufhed from the lakes, like a cloud, abſolutely obſcure the light.

The foxes are ſmall, ſlenderly limbed, delicately furred with a ſoft brown hair, and by no means rank in ſmell; feeding principally upon grain, vegetables, and fruit. They are exceedingly fleet and flexible, though not ſtrong or perſevering. When running, they wind in ſucceſſive evolutions to eſcape their purſuers, and afford excellent ſport. Their holes are uſually excavated, not in woods, but on hillocks, upon a ſmooth green ſward or lawn, where, in a morning or evening, they are ſeen playing and friſking about with their young. They feed generally amongſt the corn, and are oftenеſt found within fields of muſtard or linſeed, when it has ſprouted up high enough to conceal them.

A minor critic, on peruſal of Æſop's or rather Pilpay's fables, ridiculed the idea of foxes feeding upon grapes: but, had he conſulted any Aſiatic natural hiſtory, he would have learnt that they ſubſiſt upon grain, pulſe, and fruit, particularly grapes and pine-apples when within their range, much more than upon fleſh or fowl. Or, had he turned to the Bible, he would have there found the following paſſage in confirmation of it:—"Take us the foxes, the little foxes, that ſpoil the vines, for our vines have tender grapes."—*Canticles*, c. ii. ver. 15.

Jackalls are rather larger than Engliſh foxes; but of a

brown colour, clumſier ſhape, and not ſo pointed about the noſe. In nature, they partake more of the wolf than of the dog or fox. Their real Aſiatic name is ſhugaul, perverted by Engliſh ſeamen trading to the Levant (where they are in plenty on the coaſts of Syria and Aſia Minor) into jackalls.

Of the partridge there are ſeveral kinds, one with a white belly, and another ſomething like grouſe, only more motley feathered.

Plover too are various; and, when the weather becomes warm, ortolans traverſe the heaths and commons in immenſe flocks.

There are no pheaſants in the woods of Bengal or Bahar nearer than the confines of Aſſam, Chittagong, and the range of mountains ſeparating Hinduſtan from Tibet and Napaul. But there, particularly about the Morung and in Betiah, they are large and beautiful, more eſpecially the golden, the burniſhed, the ſpotted, and the azure, as well as the brown Argus pheaſant.

As for peacocks, they are every where in multitudes, and of two or three ſpecies. One tract in Oriſſa is denominated More-bunje, or the Peacock Diſtrict.

Cranes are of three ſorts, and all of a cærulean gray: the very lofty one, with a crimſon head, called *ſarus*; the ſmalleſt, called *curcurrab*, (the *demoiſelle* of Linnæus and Buffon,) uncommonly beautiful and elegant, whoſe ſnow-white tuft, behind its ſcarlet-glowing eyes, is the appropriate ornament for the turban of the emperor alone; and the middle-ſized one with a black head, the common grus. They return to the northern mountains about the autumnal equinox, after ceſſation of the periodical rains, with their young, in myriads of flights, frequent as the wood pigeon in North America; and ſometimes, when the wind is very violent, flocks of them mount to a vaſt height in the air, and there wind about in regular circles, ſeemingly with much delight, and venting all the time a harſh diſcordant ſcream, heard at a conſiderable diſtance.

In the wilds of Hinduſtan certainly originated the common domeſtic fowl, for there they are diſcovered in almoſt every foreſt. They are all bantams, but without feathers on their legs; the cocks are in colour all alike, what ſportſmen call ginger red; they have a fine tufted cluſter of white downy feathers upon their rumps, are wonderfully ſtately in their gait, and fight like furies. The hens are invariably brown. It is extremely pleaſant, in travelling through the woods early in a morning, to hear them crowing, and to perceive the

hens and chickens ſkulking and ſcudding between the buſhes. For food, they are neither ſo palatable nor tender as the tame fowl.

Florekins are amongſt the *non deſcripta*, I believe, in ornithology. A drawing can alone exhibit an adequate repreſentation of this fine bird; it harbours in natural paſtures amongſt the long graſs, on the extremity of lakes, and the borders of ſwampy grounds, lying between marſhy ſoils and the uplands. Hence its fleſh ſeems to partake, in colour and reliſh, of the nature and flavour of both the wild duck and the pheaſant; the colour of the fleſh on the breaſt and wing being brown, but on the legs perfectly white, and the whole of the moſt delicate, juicy, and ſavoury flavour conceivable.

There are only three claws to its feet; the roots of the feathers of the female are of a fine pink colour.

When the cock riſes up, ſome fine black velvet feathers, which commonly lie ſmooth upon his head, then ſtand up erect, and form a tuft upon his crown and his neck.

When ſet by dogs, it lies cloſe, and ſcarcely ever riſes till the fowler is ſo near as almoſt to tread upon it. The neſt of it is made amongſt the graſs.

You read of them in deſcriptions of antient knightly feſtivals of the Nevilles, Percys, Mortimers, Beauchamps, Montacutes, De Courceys, Mohuns, Courtenays, and Mowbrays, under the name, I believe, of *flanderkins*; but whether they were then native of England, I am uncertain.

The height of the cock florekin of Bengal, from the ground, when he ſtands, to the top of his back, is ſeventeen inches.

The height from the ground to the top of his head, when he holds it upright, is twenty-ſeven inches.

The length from the tip of his back to the end of his tail, is twenty-ſeven inches.

In no part of ſouthern Aſia did I ever hear of woodcocks; but amongſt the breed of ſnipes there is one called the painted ſnipe, larger than ordinary, and which well compenſates for want of the former.

Fiſhing, both with lines and diverſity of nets, is the employment of other ſets of the party; or the hawking of herons, cranes, ſtorks, and hares, with the falcon; and of partridge and leſſer birds, with the ſparrow and ſmall hawks.

Ladies now and then attend the early field: if it be to view the courſing or hawking, they mount upon ſmall gentleſt (for they are all gentle) female elephants, furmounted with arched-canopied and curtained ſeats; otherwiſe they ride on horſeback; more frequently however in palanquins, under which, as well as under the elephants and horſes, the birds, (parti-

cularly the white ſtork or paddy bird,) when pounced at by the hawks, and the little foxes, when hard preſſed by the dogs, often fly for ſhelter and protection. In general, however, the ladies do not riſe betimes, nor ſtir out till the hour of airing.

The weapons in uſe on theſe expeditions are, fowling-pieces, horſe piſtols, light lances or pikes, and heavy ſpears or javelins; and every perſon has, beſides, a ſervant armed with a ſcymitar or ſabre, and a rifle with a bayonet, carrying a two-ounce ball, in the event of meeting with tigers, hyænas, bears, or wild buffaloes. Some of the ladies (like Thaleſtris or Hypolita, quite in the Diana ſtyle,) carry light bows and quivers to amuſe themſelves with the leſſer game.

The dogs are, pointers, ſpaniels, Perſian and European greyhounds, and ſtrong ferocious lurchers. Near Calcutta a few gentlemen keep Engliſh hounds; but their ſcent quickly fades, and they ſoon degenerate.

But the livelieſt ſport is exhibited when all the horſemen, elephants, ſervants, guard, and hired villagers, are aſſembled and arranged in one even row, with ſmall white flags (as being ſeen furtheſt) hoiſted pretty high at certain diſtances, in order to prevent one part of the rank from advancing before the reſt. Proceeding in this manner, in a regular and progreſſive courſe, this line ſweeps the ſurface like a net, and impels before it all the game within its compaſs and extent. When the jungle and coppice chance to open upon a plain, it is a moſt exhilarating ſight to behold the quantity and variety of animals iſſuing at once from their coverts: ſome are driven out reluctantly, others force their way back into the brake. During this ſcene of development, rout, and diſperſion, prodigious havock is made by the fowlers, falconers, and huntſmen, whilſt the country people and children, with ſticks and ſtaves, either catch or demoliſh the fawns, leverets, wild pigs, and other young animals, which have returned into the coppice.

Inſtances occaſionally occur, where the natives of the vicinage petition the gentlemen to deſtroy a tiger that has infeſted the diſtrict, to the annoyance and devaſtation of their flocks and ſhepherds, and perpetual alarm of the poor cottagers themſelves. Although an arduous and perilous adventure, and what the gentlemen all profeſs, in their cooler moments, to reprobate and decline, yet, when in the field, they generally comply with the ſolicitation, and undertake the exploit. Their inſtant animation, not unattended with emotions of benevolence and compaſſion, preſently ſuperſedes every dictate of prudence, and, ſpite of their predetermination, they proceed

proceed to the aſſault, the villagers all the while ſtanding aloof. If conducted deliberately, with circumſpection, and with the aid of the ſepoys, they ſoon accompliſh their purpoſe, and bring in the moſt dreadful and formidable of all tremendous beaſts, amidſt the homage and acclamations of the peaſantry. But ſhould they loſe their preſence of mind, prolong or precipitate the conflict, act with incaution, or attack the exaſperated infuriated ſavage with tumult and confuſion, the event is often fatal, by his ſeizing, lacerating, and cruſhing, every creature within his reach; nor ceaſing to rend, tear, claw, and deſtroy, to the very moment of his deſtruction, or of his flight.

Sometimes do the natives entreat the gentlemen to rid them of wild buffaloes, (the largeſt of all known animals, the elephant excepted,) that have laid waſte their cultivation; and at others, to clear their vaſt tanks, or ſmall neighbouring lakes, of alligators, which devour their fiſh, or do miſchief on ſhore. So much hazard is not incurred, however, by achievements of this ſort, as from the encounter of a tiger; for though the hides of thoſe creatures reſiſt a ball from a firelock at common muſket diſtance, they are by no means impenetrable to ſhot from a rifle, or other pieces with a chamber, or of a wider calibre.

A drum, with a banner diſplayed from the hall-tent, gives ſignals to the company for their meals.

Breakfaſt is a moſt delightful repaſt: the ſportſmen return keen, freſh, ruddy, and voracious: and the appearance of the ladies in ſimple looſe attire, the elegant diſhabille of cleareſt muſlin with plain floating ribbons, and diſhevelled treſſes, captivate to faſcination. Nor is the palate leſs gratified: Engliſh, French, Italian, and Dutch viands, all combine to provoke it, by a profuſion of cold victuals, ſalted and dried meats and fiſh, hams, tongues, ſauſages, hung-beef, ſallads, chocolate, coffee, tea, freſh milk, preſerves, fruit, and eggs, rendered ſtill more grateful by the moſt ſprightly cheerfulneſs and Auroral gaiety.

After breakfaſt, conveyances of different ſorts are prepared for an airing, not merely for the ſake of airing only, but to view ſome natural or artificial curioſity or manufacture; ſome noted town, diſtinguiſhed moſque, celebrated pagoda, renowned dirgâh, or venerable mauſoleum; ſome conſecrated grove, the ſequeſtered reſidence of fakeers, or ſome extenſive proſpect from the ſummit of rugged cliffs, impending over an expanſe of water, bordering perhaps a level lawn, whoſe verdure is vaulted only, not concealed, by a diffuſed aſſemblage of ſtately columniated palms of four different ſpecies,

tufted and foliaged only, in graceful inclinations at their capitals, all equally ornamental, the date, the cocoa-nut, the beetel, and the palmyra.

Between the airing and an early dinner, the hours are irregularly difpofed, as chance may dictate, or caprice fuggeft. Some play at cricket and quoits, fwim, jump, fence, run a match of horfes, or fhoot at a mark; whilft others direct the mountaineers and woodmen (who rove about in bands for this expreſs purpofe) where to inveigle, entangle, or kill beafts, birds, fifh, and fnakes, for which they are furnifhed with variety of implements, fuch as matchlocks, tiger-bows, fpears, darts in grooves, balls in tubes, pellet-bows, limed rods, ftakes, and bufhes; faſcinating allurements, fuch as painted, fpotted, and foliaged fcreens, bells, nets, and torches, bundles of twigs, ruſhes, and reeds, artificial ducks and decoy birds, with traps, gins, fprings, fnares, and other ftratagems and inventions of wonderful enchantment, ingenuity, mechanifm, and contrivance.

It is fomewhat extraordinary, but nevertheleſs a fact, the influence of faſcination poſſeſſed by the tiger, and all of his, (the feline) fpecies, over many other creatures. 'Spied by deer particularly, they ftop at once, as if ftruck by a fpell, while the tiger lies ſtill, his eyes fixed on them, and quietly awaiting their approach, which they ſeldom fail to make gradually within his fpring; for the large royal tiger cannot run fpeedily or far. The glow of their eyes is fierce and powerful. I myſelf once paſſed a royal tiger in the night near a wood, and could plainly perceive the ſcintillations from his eyes. He was deterred from approaching us by the light of flambeaux, and the noiſe of a ſmall drum which we carried, and was beat by a ſervant for the purpoſe of fcaring him away.

Wherever tigers roam or couch, a number of birds continually collect or hover about them, ſcreaming and crying as if to create an alarm. But the peacock ſeems to be particularly allured by him; for the inſtant a flock of pea-fowl perceive him, they advance towards him directly, and begin ſtrutting round him with wings fluttering, quivering feathers, and briſtling and expanded tails. Of this enticement the fowlers alſo make their advantage; for, by painting a brown cloth ſcreen, about ſix feet ſquare, with black ſpots or ſtreaks, and advancing under its cover fronting the ſun, the birds either approach towards them, or ſuffer them to ſteal near enough to be ſure of their mark, by a hole left in the canvas for them to fire through.

Several other inſtances of the faſcination of animals I have myſelf been witneſs to in Bengal. Three or four times, where a line

a line of troops were marching in a long uninterrupted ſeries, paſſed a herd of deer; I obſerved that when their attention was taken off from grazing, by the humming murmuring noiſe proceeding from the troops in paſſing, they at firſt and for a while ſtood ſtaring and aghaſt, as if attracted by the ſucceſſive progreſſion of the files, all clothed in red. At length, however, the leading ſtag, "*vir gregis ipſe*," ſtriking the ground, ſnorted, and immediately ruſhed forward acroſs the ranks, followed by the whole collection, to the utter diſmay and confuſion of the ſoldiery: thus running into the very danger one naturally ſuppoſes they muſt have at firſt been anxious to avoid. The men, who were appriſed by the ſound of their approach, ſtopped, and made way for them. Over the heads of the others, who were heedleſs and inattentive, they bounded with wonderful agility, and fled over the plain.

Driving one evening along the road in a phaëton, and pretty faſt, I perceived a young heifer running near the carriage, with her eyes intently fixed upon one of the hind wheels; by the whirling of which the animal ſeemed completely ſtruck and affected. Thus purſuing her object for about a quarter of a mile, ſhe, by a ſudden impulſe, rapidly darted forward towards the wheel, which then ſtriking her noſe, the attention of the creature became interrupted by the violence of the friction, and was, of courſe, withdrawn: ſhe then immediately ſtood ſtock ſtill, and preſently after turned about ſlowly and made off.

Beyond all other animals, however, ſerpents poſſeſs moſt eminently this occult power: frequently are they ſeen revolved on the branches of trees, or on the ground, meditating their prey, either birds, ſquirrels, rats, mice, bats, frogs, hares, or other animals.

The ladies, as they are inclined, either read, walk, ſwing, exerciſe themſelves in archery, or at ſhuttlecock in the groves; or they ſing and play in their tents. Others, whilſt at work, are read to by their companions; of all amuſements, perhaps, the moſt delectable.

At the end of a convivial dinner, every ſoul, provided the weather prove ſultry, or they find themſelves fatigued, retires to repoſe.

On riſing from this ſieſta, (of all liſtleſs indulgences the moſt ſoothing, comfortable, and refreſhing, and certainly moſt wholeſome, all animals inclining to ſleep after nouriſhment,) carriages are again in readineſs, or light boats where a ſtream or lake is near, to give the company the evening's reſpiration,

(which the inhabitants of colder regions taſte only in poetical deſcription,) breathing health as well as recreation.

The twilight being ſhort under the tropics, the day, of courſe, ſhuts in p eſently after ſun-ſet, when cards and dice become part of the evening's entertainment. Cheſs, back-gammon, whiſt, picquet, tredrille, quinze, and loo, are the favourite games. Theſe, with domeſtic ſports, antics, gambols, tricks, pranks, and frolics, where the humour prevails; together with the ſlights of jugglers, feats of tumblers, (in which performances the Hindus are expert adepts,) and dances of the natives, wile away the time, and beguile it not unpleaſantly to the hour of ſupper, the principal meal; when a repaſt, enlivened by every elevation of ſpirit and kindly diſpoſition that can conduce to promote good humour and feſtive hilarity, terminates the day.

Theſe parties generally continue, with ſome variation in the amuſements, fifteen or twenty days; and the diſſolution of them is as generally lamented, with heart-felt regret, by the individuals who compoſe them.

LIII. *Obſervations upon the Monſoons, as far as they regard the Commerce and Navigation of the Port of Bombay*.*

OUR readers will not require to be told that our year is divided into two grand ſeaſons, or, as they are called, the ſouth-weſt and north-eaſt monſoon; that the firſt generally prevails from May to the middle of September inclusive, the other during the remaining months; yet we muſt premiſe this as an introduction of what follows.

We need ſcarcely to obſerve, that during the ſouth-weſt monſoon all the ports and roadſteads on this ſide of India deny approach; ſo much ſo, that between the 15th of May and the 1ſt of September ſhips are precluded by their policies from touching upon the Malabar coaſt, or from lying in Surat roads between the 1ſt of May and the 1ſt of September. Generally ſpeaking, the monſoon is conſidered to extend from Dunder-head, the ſouthern extremity of Ceylon, to the Perſian Gulf; in order to attain which, they who ſhould fail at this ſeaſon would be obliged to make what is called a ſouthern paſſage, that is, go firſt to the ſouth of the equator before they could ſtretch over to the weſtward; a voyage that would occupy, for Muſcat about forty days, and

* From the *Aſiatic Annual Regiſter for* 1802.

to

to Buſſorah about two months. The ſame objection exiſts againſt ſailing at this ſeaſon to any part of the Arabian coaſt. As for the Red Sea, it is conſidered in vain to attempt entering it at this ſeaſon; nor can it be ſaid to be favourable to ſail now to the Cape, the Mauritius, or any port to the weſtward.

To the other ſide of India, on the contrary, it is now the moſt advantageous period of departing. From the middle of April, even to the middle of Auguſt, a voyage to Madras may be made in about 12 or 15 days; to Bengal from 15 to 20 days: after this time it becomes exceſſively tedious, from the neceſſity of keeping to the eaſtern ſide of the bay, to avoid the violent weather on the Coromandel coaſt. For the ſame reaſon the ſouth-weſt monſoon is eligible to leave Bombay for any of the ports in the Gulf of Bengal or the Streights of Malacca; hence alſo it is the ſeaſon for ſailing to China: after the 20th of Auguſt, however, what is called the direct paſſage to China becomes very precarious, with much probability of finding blowing weather in the Chineſe ſeas.

With regard to the ports from which ſhips may be expected to arrive at Bombay during this monſoon, it may be laid down as a general rule, that the quarters favourable to ſail to during any ſeaſon, are thoſe that it is unfavourable to expect arrivals from, and *vice verſa*: hence from the Perſian Gulf, the Red Sea, the Cape of Good Hope, and the weſtward in general, this is the moſt ſeaſonable period to expect arrivals: from Muſcat a trip may now be made in 10 or 12 days, from Mocha in 20 days, and Suez in about a month. It ſhould be remarked, that after September the Red Sea admits of no egreſs; ſhips conſequently remaining there beyond that time, muſt continue there all the north-eaſt monſoon, and are ſaid to have loſt their paſſage: on this account, the 25th of Auguſt is the lateſt day to which our cruiſers are allowed to remain at Suez. From the Cape a paſſage may be made in five or ſix weeks; from the Mauritius, in three weeks or a month.

The ſouth-weſt monſoon is alſo the moſt favourable ſeaſon in which a paſſage may be made from Batavia or any ports to the eaſtward through theſe ſouthern ſtreights: from Batavia to Bombay, in particular, a paſſage may be made in about 35 days. From Madras and Bengal, during the ſouth-weſt monſoon, it is neceſſary to make the ſouthern paſſage in order to reach Bombay: this will require, in a paſſage from Madras, from 30 to 40 days, and from Bengal from 45 to 60 days, from the neceſſity of working out of the river, and beating down the bay to clear Acheen Head. From the

Streights

Streights of Malacca it is an arduous taſk to ſail for this port, or even to any one on the peninſula of India, owing to the difficulty of working round Acheen Head.

We have now to treat of the north-eaſt monſoon, or the ſeaſon which may be conſidered as included between the 15th of Auguſt and the 15th of April; in which the firſt circumſtance that occurs to us to remark is, that our coaſt is rendered in a peculiar manner ſecure and favourable to navigation; it is now conſidered the moſt eligible period for ſailing to the Perſian Gulf, and in general to all ports to the weſtward. To Muſcat the trip is generally 15, and to Buſſorah 28 days. The time ſuitable for ſailing to Mocha and Suez is from the middle of February to the middle of March, when a paſſage may be made to the firſt in 18 days, to the ſecond in 25. If a ſhip be delayed till the latter end of March or the beginning of April, the paſſage becomes more tedious, being then obliged to make the land to the ſouthward of the iſland of Socatra before the gulf can be entered, on account of the ſoutherly winds which prevail, and a current ſetting to the northward. After the 15th of April, a ſhip bound to the Red Sea would be very likely to loſe her paſſage.

Between the 15th of Auguſt and the 15th of September it may be conſidered favourable to ſail to Madras and Bengal; but after this time the ſeaſon is ſuſpended, owing to the ſetting in of the north-eaſt monſoon on the other ſide of India, which cloſes the ports on the coaſt of Coromandel, Golconda, and Oriſſa, between the 15th of October and the 15th of December; at leaſt this period is excepted in common policies of inſurance. After this time, again, a paſſage may be made to Madras in 30, and Bengal in 50 days. This ſeaſon may be deemed unfavourable to the coaſt of Pegue and the Streights of Malacca; but for the Streights of Sunda, Batavia for example, it is the beſt adapted—a paſſage thither may be made in 35 days.

With regard to the ſeaſonable imports in this monſoon, it is at no time more advantageous than now for coming from the Coromandel coaſt, and, in ſhort, the whole bay: a paſſage may be made from Madras in 20 days, from Bengal in a month, and Penang a month. From the Perſian Gulf it is no leſs favourable, the paſſage from Muſcat being about ten days; and from Buſſorah 28. The Red Sea is now cloſed; nor is it reaſonable to expect arrivals from the Cape or the Streights of Sunda; from the latter, in particular, it is almoſt impoſſible at this ſeaſon to make a tolerable paſſage.

LIV. *Me-*

LIV. *Method of obtaining inodorous Benzoic Acid.* By M. F. Giese *.

THE benzoic acid, such as we obtain it in the dry or humid way, always retains a peculiar strong agreeable odour, which has hitherto been considered as a particular character of this acid. The numerous experiments I have made on this acid show that chemists in this respect have been in an error, and that the benzoic acid may be deprived of all its odour without injuring its principles or altering its nature.

I was led to this observation by remarking, that the same acid extracted from the urine of graminovorous animals, when deprived of all urinous odour, is perfectly inodorous. This circumstance induced me to believe that the odour of the benzoic acid might be foreign to it; and to ascertain this fact I made the following experiments:

I united odorous benzoic acid to a solution of potash, and then precipitated by muriatic acid. On each repetition of the experiment the odour was sensibly diminished, and after the third it had totally disappeared.

As the acid retained all its characters, this seems to prove that in these operations it had experienced no particular modification †. This result was previously indicated by its acquiring, in the progress of the experiment, the odour of benzoic acid obtained in the humid way, which is much weaker than that of the same acid obtained by sublimation.

I afterwards invented another method, more direct and less troublesome, for depriving this acid of its odour. It is founded on the greater solubility of the benzoic acid in spirit of wine than in water; and on the solubility of the benzoic oil, which is the principle of its odour, in diluted spirit of wine. This method is as follows:

Dissolve benzoic acid in as small a quantity as possible of spirit of wine: filter the solution, and drop water into it until no more precipitate is formed, or until the precipitate formed begins to be redissolved. Separate the liquor by filtration, and dry the acid, which remains on the filter, at a gentle heat.

* From Scherer's *Allgemeines Journal der Chimie*, February and March 1802.

† I can certify that a specimen of this acid, shown to me by the author, was absolutely free from odour. I requested M. Giese to subject the inodorous acid to sublimation, in order to ascertain whether a decomposition experienced by the heat was not the cause of its odour. He complied with my request; but he observed no alteration in the acid, nor had it resumed its odour.—Scherer.

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I ſhall here add, that having ſaturated the benzoic acid with lime, and decompoſed the benzoate thence reſulting by the muriatic acid, I obtained an acid without odour; and that M. Richter obtained the ſame inodorous acid by decompoſing the benzoate of potaſh by acetite of lead, and then the benzoate of that metal by the ſulphuric acid: but of all theſe methods that by ſpirit of wine is to be preferred.

LV. *On the Mammoth. By Governor* POWNALL.

To Mr. Tilloch.

SIR,

I READ, at Bath, the account which the Philoſophical Magazine, publiſhed by you, gave the public of the mammoth. In my way from Bath to this place, I continued a few days in London: I went twice to ſee the ſkeleton of this enormous animal: the firſt time to take a general view of it; and ſome days after, when I had fully reaſoned in my recollection on the general conſtruction of it, I went a ſecond time to examine it in detail, as far as my ſuperficial knowledge in comparative anatomy would enable me.

I ſhall not in this letter go over all the parts to which I gave my attention, but notice only thoſe parts on which ſome doubts remained with thoſe who had not ſeen it, and which, rightly underſtood, lead to ſome probable conjectures as to the mode and time of its exiſtence in life. I am, Sir,

Your moſt obedient humble ſervant,

Everton Houſe, Jan. 1, 1803. J. POWNALL.

DOUBTS were made as to ribs being ſet edgeways, ſo different from all other animals of our earth; yet ſuch is the fact, as appears not only from the inſertion of their heads, but from their curvature; alſo from their ſides, wherein is the groove into which the cartilages, by which they are connected, were inſerted. Theſe ribs appear to be of the ſame form and to be in the ſame poſition as the ribs of fiſhes, and ſo deſigned for the ſame purpoſe, to reſiſt an external compreſſure of more weight and force than the preſſure of the atmoſphere.

The printed deſcription left it totally undecided whether this animal had hoofs or toes. On examining the ſetting on of the foot, it appears that it hath the eight uſual bones, in two rows, four in each row, in the carpus, which all animals having digits or toes have: and it hath five toes, whereon,

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as appears from the form of the end-bones, it had nails, not claws.

The poſition given to the tuſks ſeemed doubtful; but, on a view of the fact, it is deciſive that they could not have been placed otherwiſe. They are of a ſpiral curvature of one quarter turn: they are ſo inſerted into the head as to go back alongſide the ſhoulders, but at ſuch a diſtance, as, by the turn of the head with ſome curvature of the body, to reach the ſides and hinder parts, and from their conſtruction and poſition point out evidently, at leaſt to me, that they were weapons of defence againſt ſuch of its enemies as might attack it in the flank or rear, and of deſtructive offence alſo in ſuch caſe. Of this more hereafter.

The neck is ſo ſhort that the animal could not reach the ground with its mouth: the line from the withers to the end of the under-jaw is about one-third of the line from the withers to the ground. I did not take an actual meaſure of this, but I will venture to aſſert it from my habit in drawing.

This animal, if a grazing animal, might indeed, as the mooſe deer do, feed on young ſhoots of the woods, or the bark; or, by going into moraſſes up to the breaſt in water, feed on the long graſſes and water-plants which grow therein: but it is decidedly a carnivorous animal. The woods of the earth in which this animal could live, move, and ſuſtain its being, muſt have been totally different from ſuch as at preſent cover the face of the earth; otherwiſe his enormous form, with the poſition of his tuſks, muſt have rendered him incapable of penetrating or paſſing through them.

Now here let the ingenuity and wit of our philoſophers moſt renowned as naturaliſts ſearch into the fact, and tell us what ſort of animals could have been his prey, and where ſuch could exiſt in ſufficient abundance to ſuſtain this enormous animal; and if any ſuch ever did exiſt, which we now know nothing of, how he could, be his capacity for velocity ſuppoſed to be what it may, how he could hunt them in woods into which he could not penetrate, and through which he could not paſs.

The queſtion then ariſes and remains in doubt, Where muſt we look for his habitation and his food? Not being able to find either in the preſent ſtate of the earth, my reſearch is led to ſeek it under ſome other ſtate of this planet. In ſearching for ſuch ſtate of things, I go to the firſt information we can obtain of the *hiſtory of this fact*, in the divine book of Geneſis, written under inſpiration: and there I am taught that the original ſtate of this planet, *in the firſt period* of its exiſtence, was that of an aqueous planet. The waters,

over

over the face of which the Spirit of God moved, covered the whole furface of the globe, and had remained in that ſtate for two uncertain periods, until the working of nature under the command of God forced up and elevated the earth in parts, ſo that the waters were gathered together, which took place in a *third period* of the progreſſive exiſtence of this our planet.

But apart all authority, any true philoſopher, who meets by tracing back the operations of nature in her progreſſive advance to the preſent ſtate of the planet, will find it in its firſt period an aqueous planet; will find that light or caloric, or whatever that firſt power was, ſpecially gave courſe to other powers; and that the powers of evaporation, both expanſive and attractive, were and are the cauſes of the ſeparation of the elaſtic fluid, the atmoſphere; that the earth has been thrown up from the bottom of theſe waters by various exploſions and volcanic eruptions: and that the earth became, under theſe proceſſes, in its vegetative ſtate, a fit habitation, firſt, for the fowls of the air and all flying inſects; and next for the beaſts of the field and all creeping things; and laſtly, for man, exactly according to the philoſophic deſcription given in the divine narrative. But while he conſiders this advancing progreſſion, he will find nothing to decide as to the length and continuance of each of theſe periods. That theſe periods are not to be underſtood as *days*, is part of the fact. Becauſe three of theſe periods were paſt, according to the narrative itſelf, before that diviſion of time took place, which was not till the fourth period.

I ſhall now, grounding myſelf on the fact as above ſtated, aſſume that this planet was, in its firſt period of exiſtence, an *aqueous planet*; and finding nothing to decide or determine the continuance of this period, aſſume alſo that it continued, according to the courſe of nature in her progreſſion, in this ſtate for an indefinite period; and further, that in this period and in this ſtate of the planet "God created great whales and every living creature which moveth, which the *waters brought forth abundantly* after their kind." I find it difficult to conceive that theſe waters, which are deſcriptively ſaid thus to *bring forth ſo abundantly*, ſhould remain for four periods of the planet's exiſtence totally unproductive till the fifth. The only way that I find to reconcile this difficulty in the divine narrative, is, that theſe marine beings are omitted to be noticed until they are claſſed with all other living terreſtrial creatures under one head, according to the order of method, not the order of time, in the fifth period, when the earth became a proper *habitation* for ſuch terreſtrial

trial creatures. Whether the general denomination of *great whales*, ſo peculiarly expreſſed here, extended to the leviathan, the behemoth, and other ſpecies of great animals, I am not critic enough to judge: but that there were ſeveral other great animals in theſe waters is a fact.

On this ground I am diſpoſed to think that, if any remains of any great animals are found amid the wreck which the parts of this planet have ſuffered in the revolutions of its nature, whoſe ſpecies are not now to be found in living exiſtence, and to whom the preſent ſtate of the earth could neither give an *habitation* or food, even a cautious naturaliſt may, on theory founded in a combination of circumſtances, fairly ſuppoſe that thoſe great animals had their exiſtence under the circumſtances of the firſt period of this planet as an aqueous one, and were deſtroyed by the revolution which converted it into a terreſtrial one; and that even thoſe who were not deſtroyed in that cataſtrophe muſt have become annihilated, as the preſent ſtate of the earth is not ſuited to their exiſtence.

The ſkeletons of this ſpecies of animal, which is by a Ruſſian word denominated mamonth or mamoud, as being enormous like the elephant, and which might juſt as properly have had the name leviathan, or behemoth, given to it, are found in different and diſtant parts of the world, and under different climates, as on the banks of the Ohio, in the dominions of the ſtate of New York, and on the banks of the Obie in Siberia. This circumſtance again points out that theſe animals muſt have inhabited ſome element wherein the climates did not vary to the degree in which they now do on the earth, and whereby there was a general free communication from one ſide of the globe to the other, which doth not now take place. Moreover, as the earth is now conſtituted, and as the animals thereon exiſt, the indigenous animals of Europe and of America, howſoever ſimilar in their external apparent claſſes, are variations in the one country from what they are in the other.

Beſides the ſkeletons of theſe animals called mammoth, there have been found in other regions of the earth parts of other ſkeletons of enormous animals. The ſkeleton of one ſuch, which is now in Spain, was found in South America. This, from the drawing made of it, appears to differ from the mammoth: but, having been accuſtomed to doubt the vagueneſs of draughts, I can ſuppoſe that this may, on examination, be found to be of the ſame nature *.

There

* We have reaſon to believe, from a correct drawing, and ſome particulars which have reached us of the animal here alluded to, that it is of a different

There are alſo found, in different regions in the earth, the exuviæ and remains of animals of a ſcale in magnitude much beyond thoſe it affords in its preſent ſtate, about which it ſeems almoſt impoſſible to fix any line of conjecture. They are found in all ſtrata, the marine ones chiefly in calcareous ſtrata: this ſkeleton lay in a calcareous ſtratum.

The ſuppoſition that this animal was a marine one, and dwelt in the ocean, relieves the account of it from all difficulties as to its habitation and food. What the woods of the preſent earth deny, the ocean gives full and free courſe to—all its enormous animal capacities of motion. The *abundant ſupply* of the ocean could give food for this carnivorous animal, and food which came within its power to attain, on the banks of flat fiſh, and in the beds of ſhell fiſh. This removes all difficulty as to its ſuſtenance. That the ocean did bring forth ſuch food in ſuch abundance, the phænomena of the marine animal compoſition of the ſtrata of the preſent ſtate of the earth evinces.

That this animal was carnivorous appears to be a decided fact; it might therefore live in an element where was no grazing food: from its enormous bulk it would require a ſupply of animal food which the earth could not give, and which could only be found in the abundance which the waters bring forth.

There are parts in the *debris* of the ſkull which have ſome comparative reſemblance to the whale, as to the purpoſe of breathing under water; and from the width of the jaws, ſomewhat ſimilar to that of fiſh, one may imagine, when imagination is ſet to work, that this animal might have had in thoſe parts ſome glands calculated to carry on the ſame operation as the gills of fiſh perform. The ribs, as obſerved above, more ſimilar to thoſe of fiſh than to thoſe of terreſtrial animals, are by their conſtruction and poſition ordained to reſiſt a much heavier and more forcible external compreſſure than the atmoſphere creates.

I ſhall make no apology for any part of this *theory*, becauſe, being declared to be theory, every one is at liberty to approve or diſapprove the whole or any part thereof; yet I cannot but think that ſome very ſober analytic philoſophers may repoſe their imaginations if not their conviction upon it, until the preſent or ſome future ſyſtem of philoſophy ſupplies them with a better. I will therefore venture to ſay to any philoſophical ſociety, royal or liberal,

——— Si quid noviſti rectius iſtis,
Candidus imperti: ſi non, his utere mecum.

different ſpecies from the mammoth. We ſhall here mention only one ſpecific difference—its ribs are nearly cylindrical.—EDIT.

I will

I will not cloſe my reflections on this ſubject, which was found in North America, and is now exhibited in London by Mr. Peale, a young American, by whoſe perſevering induſtry it was dug up, without ſaying in very truth, and not in compliment, that this exhibition will derive every advantage which can ariſe from an object of this ſort, from the modeſt ſcientific knowledge and the preciſeneſs of information which this young man, in the true analytic way of an American, explains it; and from the collection of other articles with which he accompanies ſuch explanation as with a commentary.

LVI. *Remarks on the preſent State of Aëroſtation.* By *Mr.* G. J. Wright*.

SUBSEQUENT to the diſcovery of marine navigation, the daily proofs of aërial flight, as witneſſed among the feathered tribe, ſerved to ſuggeſt to the antients the probability of piercing the unexplored regions of the atmoſphere: various have been their attempts for this purpoſe, which (agreeably to the then pre-eminence of mechanical over the other branches of philoſophy) were confined to the invention of machines to aſſiſt man himſelf in imitating the motions of the feathered race, but more particularly to the contrivance of flying automata, as may be learnt from the writings of many authors.

To enumerate and particularize theſe inventions would be of no avail, eſpecially as the bare recital of many of them would at once confirm their abſurdity; ſo that we may reckon nothing to have been practically concerted toward aëroſtation till the experiment of one Guſman, a Portugueſe friar, who is reported, early in the 18th century, to have launched a paper bag into the air; which however ſoon fell, after attaining the height of 200 feet.

Many doubts have ariſen reſpecting the truth of this ſtatement, principally from the ſuppoſed unacquaintance of the philoſophers of that early period with the qualities and varying denſities of aërial fluids, as alſo the little probability that an elaſtic fluid could be confined, for any length of time, by paper, of which it has been aſſerted that the pores are indeed impermeable to air, though water eaſily percolates them: hence it has been inferred that the particles of water are finer than thoſe of air. 'Tis certainly true that air may be confined by paper, provided ſuch air be deſtitute of moiſture, and

* Communicated by the Author.

incapable of exerting a chemical action thereon: but if water paſſes the pores of paper, it is moſt probably occaſioned by its firſt effecting a ſolution of the mucilage, by which means the reſt of the fluid finds an eaſy paſſage; for, the hotter the water, the quicker does it percolate; and this is not attributable to any ſuppoſed attenuation of the individual particles of the fluid, but to an actual ſolution of the paper itſelf; otherwiſe the ſtrength of each ſingle fibre would remain unimpaired by the difference of temperature in the water; the contrary to which the manufacture of paper itſelf will evince.

The difficulty, therefore, of obtaining the gaſes in a ſtate of dryneſs in ſo large a quantity as is required for aëroſtatic experiments, will ever remain an impediment to the uſe of paper for any other than balloons of ſmall diameter, and on the principle of Montgolfier. Two brothers of this name, natives of France, conſidering the difference in the ſpecific gravity of heated and cool air, juſtly imagined, that if a bag, ſufficiently large, were filled with the former, the weight of the incloſed heated air and bag together would be leſs than an equal bulk of atmoſpheric air of ordinary temperature, and that ſuch an apparatus would aſcend till it ſhould attain that elevation where the reſpective gravities would correſpond.

Experiment fully verified the opinion they had formed, and M. Pilatre de Rozier was the firſt to make trial of its ſecurity.

The inconveniences peculiar to machines rendered buoyant by heated air, aroſe from the impoſſibility of keeping up the elevated temperature of the incloſed air without the continued renewal of fuel, and that in large quantity; whereby the travellers were expoſed to great danger from the occaſionally ſudden and unavoidable expanſion of the flames, and their inability to command that uniformity of rarefaction ſo neceſſary to the ſafety of the voyage.

As aërial chemiſtry had been before this time making rapid advances, ſo the philoſophical world, through the indefatigable labours of the honourable Mr. Cavendiſh, had been made acquainted with the properties of inflammable air, whoſe ſpecific gravity, in a tolerably pure ſtate, is at leaſt twelve times lighter than atmoſpheric air. Doctor Black firſt applied this newly diſcovered gas to balloons, by ſuggeſting its incloſure in an air-tight bag, as capable of raiſing itſelf into the atmoſphere, agreeably to the common hydroſtatical axiom, that bodies immerſed in a fluid heavier than themſelves muſt inevitably float in that fluid; and that, as the denſity of fluids is proportionate to their heights, ſo the lighter body will continue to riſe till its gravity ſhall correſpond

ſpond with that of an equal bulk of the fluid in which it is immerſed. Although Dr. Black undoubtedly firſt ſuggeſted the propriety of applying inflammable air to aëroſtatic purpoſes, Mr. Cavallo had the honour of firſt putting it into practice, which we find him to have been engaged in performing in the year 1782: but his experiments went no further than a demonſtration of the doctor's ſuggeſtions; and the aſcent of ſoap-balls filled with inflammable air (as being the firſt experiment of the kind) is an original idea, for which we are indebted to him.

The firſt inflammable-air-balloon was launched on the continent by Meſſrs. Roberts and a Mr. Charles in the year 1783; and the greater expediency of theſe latter machines over thoſe elevated by heated air, ſoon raiſed them to that pre-eminence they ſeemed juſtly entitled to: yet even with theſe there was conjoined the diſadvantage of not being able to raiſe or lower them without a loſs of ballaſt in the firſt, and of gas in the latter caſe. This ſuggeſted the idea of incloſing a bag of heated air in one of inflammable air, whereby, on varying the temperature of this inner balloon, the whole apparatus could be raiſed or lowered *ad libitum*, without loſs of gas or ballaſt. But as the vicinity of fire to hydrogen air and common air endangers a mutual exploſion, ſo this unfortunate plan deprived the world of that moſt intrepid philoſopher M. Pilatre de Rozier, who has the honour to bear the palm of aëroſtation, in being the firſt man who ever abandoned himſelf to the atmoſphere in a balloon.

If we conſider the natural diſpoſition of Frenchmen, ever prompting them to the purſuit of novelty, we ſhall not be ſurpriſed to find them warm advocates for the progreſs of this new art; eccentricity in the choice of their reſearches and amuſements having been ever a prominent trait in their national character. Enlivened by the native ſoftneſs of their climate, their diſpoſitions partake of that gaiety which is to be found only in a country like theirs, where a leſs ſluggiſh atmoſphere and more uniform temperature tend to preſerve a conſtant vivacity of mind. A latitude ſo favoured with ſerenity of ſeaſon produces an abundance of vegetables and fruits, the want of a greater mixture of which in the diet of Engliſhmen cauſes the more prevalent ſedateneſs of their manners, ſubdues a tendency to volatility, and keeps them from wandering from one purſuit to another. Hence we are leſs likely to witneſs among ourſelves that ſudden enthuſiaſm for the progreſs of any new art, and eſpecially of this (to ſome) ſeemingly unimportant one: we have therefore had very few inſtances here of balloon excurſions undertaken by

really philoſophical men; and, except Mr. Baldwin, none have contributed aught to the ſcience. His treatiſe *, compiled from the memoranda of a ſingle voyage, is without its equal, and under ſuch a philoſopher the art muſt ſoon have attained all the perfection it could be capable of; while its preſent low ſtate can be attributed only to the impoſſibility of finding his rival. The treatiſe of Mr. Cavallo † is an excellent book for practical purpoſes; and in theſe two volumes we find all the yet aſcertained facts relating to aëroſtation ‡; the pamphlets compiled by others being of no value, as containing for the moſt part a repetition merely of trifling occurrences of no avail to future balloonifts.

Subſequent to the experiment of Meſſrs. Charles and Roberts, many voyages were undertaken, both in France and this country, during the years 1784 and 1785: and after the public curioſity was in ſome meaſure abated, the purſuit itſelf ſunk in the general opinion, and received attention only from a Mr. Blanchard, a French gentleman, who for years before had been deviſing various methods to fly by mechanical means. This amateur (who has made near fifty aërial voyages, and who, in his ſeveral attempts to improve the art, has met with ſome unfortunate accidents) is the original inventor of the parachute; but his eſſay therewith was not attended with ſucceſs to himſelf §, although the animals he at times had committed to it for deſcent never experienced the ſlighteſt ſhock. Excepting then Mr. Blanchard, we find the art making no further progreſs; and even the attempts of this gentleman for the purpoſe proved abortive.

The ſecond æra of aëroſtation may be ſaid to commence with the eſtabliſhment of the aëroſtatic ſchool at Meudon, in the vicinity of Paris ‖; and the firſt immediate ſervice of a balloon appears to have been derived in the battle of Fleurus, in the Auſtrian Netherlands, where from an elevated ſtation the French aëronaut beheld the movements of the enemy; and by indicating the ſame by a telegraph purpoſely attached to the car, the battle is reported to have been gained by the French, principally from this contrivance to overlook the ope-

* Aëropaidia, or Narrative of a Balloon Excurſion from Cheſter; by T. Baldwin, A. M. 1786.

† Hiſtory and Practice of Aëroſtation; by Tiberius Cavallo, F. R. S. London 1785.

‡ In the French language we have *Deſcription des Expériences Aëroſtatiques, par M. Faujas St. Fond*, 2 tom.

§ In an experiment at Bâle, in venturing to deſcend by his parachute, he unfortunately broke his leg.

‖ See the account of the French aëroſtatic inſtitute in the ſixth volume of the Monthly Magazine.

rations

rations of the combined armies. Various reports have at times reached us concerning the pretended flouriſhing ſtate of this aëroſtatic ſchool; but during the few years of its eſtabliſhment no improvements appear to have been made further than the compoſition of the varniſh, which is brought to the greateſt perfection; and Mr. Garnerin informed me the eſtabliſhment itſelf is now given up.

We find then that the apparatus itſelf has undergone no confirmed improvement; perhaps from the purſuit being generally attended to by enthuſiaſts in novelty, ſtrangers to genuine ſcience natural or mechanical. Thus an aëronaut in the preſent day is compelled to go in the direction of the wind; and in deſcending, calmly ſits in his car to be knocked againſt every tree, houſe, or hedge, that may come in his way. So long, therefore, as aërial adventurers are liable to ſuch dangerous dilemmas, it is no wonder we find ſo few inclined to repeat their voyages; as the tranſitory enjoyment of a view above the clouds, is ſeldom ſufficient to incite a ſecond attempt under ſuch threatening circumſtances.

The reſtoration of peace affording to foreigners an opportunity of viſiting this country, whether prompted by curioſity or to exhibit the productions of their inventive genius, this criſis proved a means of again exciting the attention of the Engliſh public to the almoſt forgotten ſubject of aëroſtation, as revived by the advertiſements of Mr. Garnerin; a man of an ingenious turn of mind, without that collateral acquaintance with the ſeveral ſciences on which reſts the only ſure foundation for improving the arts, and eſpecially this peculiar branch of philoſophy, which ſeems to be his native *forte*.

Having made a number of aërial voyages, his mechanical acquaintance with the requiſites for inſuring ſucceſs was confirmed by frequent experience; but further than this we do not find him to have attained. He is alſo the firſt aëronaut that has ſucceeded in a ſafe deſcent by the parachute—an experiment which is of the firſt conſequence to the progreſs of aëroſtation. The late voyages made in this country by this latter gentleman are freſh in the memory of every one, and we have only to regret that ſo experienced an adventurer ſhould poſſeſs ſo ſmall a ſhare of the knowledge requiſite to raiſe aërial navigation to the perfection it might perhaps otherwiſe ſoon attain.

As an advocate for aſcertaining the iſſue of whatever may be dubious in the preſent ſtate of our knowledge, I felt anxious to ſeize ſo happy an opportunity of inveſtigating what degree of diminiſhed preſſure the human conſtitution could ſupport, as preſented in the intended experiment with the parachute;

rachute: for this reaſon I offered to Mr. Garnerin, that, as his balloon was capable of carrying four perſons, it would be fully adequate to the conveyance of two, together with the parachute and ballaſt: under ſuch circumſtances it would be neceſſary to ſuſpend the parachute beneath the car; and my intention was to occupy the latter myſelf. An offer ſo advantageous for ſecuring Mr. Garnerin's machine (otherwiſe left at random) was rejected by him, from the acknowledgement of his doubts reſpecting the event of ſo novel an experiment. But I truſt this experiment will not long remain unattended to by ſuch as may have an opportunity of performing it: the effects ſubſequently taking place from the loſs of a weight of upwards of 200 pounds at an elevation of 10,000 feet, are not ſo terrific as might be imagined; as during this after-aſcent no danger could attach to the machine; for, its neck being open, and thereby affording an exit to the gas, now ſomewhat more expanded by the abſence of the mechanical preſſure of the 200 pounds juſt loſt, yet gradually ſtill more expanding itſelf as it attains in this aſcenſion a zone of air of leſſer denſity, would neceſſarily prevent any rupture from that cauſe; while, if the aëronaut found his reſpiration too much affected to allow his attainment of the utmoſt height ſurmountable under theſe circumſtances, he could have nothing to fear ſo long as he has the valve at command. Neither have we any cauſe for apprehenſion from the velocity likely to take place, if the traveller is not too near to the body of the balloon, or in a fitting poſition; in both which caſes it is doubtful whether the approximation to a vacuum * in the *wake* and immediately in the vicinity of the lower pole of a large ſpherical body, aſcending with great velocity, might not endanger *aſphyxia*, from the ſuddenly diminiſhed denſity of the air received into the lungs †.

At the ſame time, to ſuch as deſcend by a parachute from a balloon left at random, I would adviſe an attention to the following ſimple precaution, which cannot fail of inſuring the

* Agreeably to what we learn in projectiles, that a body moving with a velocity of 1200 feet in a ſecond, leaves behind it an actual vacuum; alſo exemplified in the common exerciſe of ſwinging, where a ſlightly ſuffocating ſenſation is experienced in the retrograde motion of the machine, occaſioned by the perſon ſitting in the wake formed by the recoil of his own body.

† As I have no intention to ſpeak in this place of the effects likely to enſue to an aëronaut in caſes where, the valve being unexpectedly found out of repair, he is obliged to remain at the then unavoidable equilibrium, I ſhall reſerve theſe points of diſcuſſion as the ſubject of a paper I propoſe to tranſmit at a future opportunity, in immediate reference to the probable effects of diminiſhed atmoſpheric preſſure on the animal ſyſtem.

ſpeedy

ſpeedy deſcent and recovery of the latter. In aſcending with a parachute according to the preſent conſtruction (the aëronaut being out of the reach of the neck of the balloon), it will be adviſable to leave the neck open about a foot or more: previous to the aſcent procure a cord whoſe length muſt equal half the perpendicular circumference of the balloon when at its full diſtenſion; attach one end of the cord to the zenith of the balloon externally, or to the netting immediately over it, and (leaving it detached throughout the whole of its remaining length) to the other end faſten a weight of about 20 pounds. I ſay, when the ſeparation between the parachute and balloon is made, the latter, being deſtitute of any other poiſe, will gradually yield to this above-mentioned weight, and by its means the open neck of the balloon will progreſſively be made to aſcend; while the zenith will be drawn downwards, the machine thereby inverted, and the preſſure of the external atmoſpheric air will in a ſhort time force out the inflammable gas, and the whole bag quickly deſcend *.

It would appear, from the above ſhort review of the ſtate of aëroſtation, that we have as yet made no further progreſs than the attainment of the means of riſing into the atmoſphere, of aſcending and deſcending a very limited number of times, and of departing from the machine in ſafety in caſe of any immediate wiſh on the part of the traveller when his ſtay therewith appears hazardous. As theſe are matters ſufficient to diſpel apprehenſion from the minds of thoſe who may be inclined to attend to this branch of philoſophy, it may not be amiſs to ſubjoin thoſe requiſites and precautions, an attention to which will not fail to enable the amateur to purſue this modern diſcovery with expedience and economy.

The ſtuff uniformly made uſe of in the conſtruction of balloons to be raiſed by inflammable air is ſilk luſtring, (*taffetas luſtré*,) which is a ſubſtance extremely well calculated for the purpoſe, as poſſeſſing the valuable properties of cloſeneſs of texture and uncommon ſtrength, yet of little weight †: but the

* Finding Mr. Garnerin, notwithſtanding repeated applications, averſe to my accompanying him in the manner I propoſed, I adviſed him to take advantage of this eaſy method of ſecuring his machine; but he choſe rather to follow his own uncertain project of faſtening the neck of the balloon, in order that, as it afterwards continued to aſcend to a more rare atmoſphere, the force of the expanding inflammable air (thus prevented from eſcaping) might overcome the reſiſtance of the ſilk, and cauſe a rupture ſufficient to let out the gas: but in our ſmall iſland the machine might have been irrecoverably loſt in the ocean before theſe effects had taken place.

† Balloons to be raiſed by heated air are conſtructed of linen ſoaked

the price of this ſilk, though more moderate in France, is in this country ſo high * as to augment the expenſe of a middling-ſized balloon almoſt to a prohibition to any but the wealthieſt individuals. I do not ſee, therefore, why ſtrong cambric muſlin, rinſed in drying oil †, (previous to ſewing the pieces together,) ſhould not fully anſwer every purpoſe. After providing the neceſſary quantity of the ſtuff, and each piece having been properly prepared with the drying oil, let the correſponding edges be ſewed together in ſuch a manner as to leave about half an inch of one piece beyond the edge of the other, in order that this may, in a ſubſequent row of ſtitches, be turned over the latter, and both again ſewed down together: by ſo doing, a conſiderable degree of ſtrength is given to the whole bag at the ſeams, and the hazard of the gas eſcaping doubly prevented. Having gone in this manner through all the ſeams, the following method of Mr. Blanchard is admirably calculated to render them yet more perfectly air-tight. The ſeam being doubly ſtitched as above, lay beneath it a piece of brown paper, and alſo another piece over it on the outſide; upon this latter paſs ſeveral times a common fire-iron heated juſt ſufficiently to ſoften the drying oil in the ſeam: this done, every interſtice will be now cloſed, and the ſeam rendered completely air-tight.

The neck of the balloon being left a foot in diameter and three in length, and all the ſeams finiſhed, the bag will be ready to receive the varniſh, a ſingle coating of which on the

in a ſolution of alum or ſal-ammoniac and common ſize: Mr. Cavallo recommends a gallon of water to a pound of each of the two ingredients: it may then be ſewed into the required ſhape, and afterwards once varniſhed on the outſide with merely drying linſeed oil, adding a ſmall quantity of neat's-foot oil to prevent its being ſticky. The *liquor ſilicum*, or liquor of flints of the chemiſts, prepared by melting together one part of ſand or powdered flints and four parts of fixed alkali, might, perhaps, be advantageouſly ſubſtituted for the ſaline ingredients above mentioned, as rendering paper or cloth varniſhed therewith perfectly incombuſtible.

* Silk luſtring may be purchaſed on the continent at five ſhillings the yard, but here for not leſs than nine.

† In rendering oil drying for aëroſtatic purpoſes we ſhould avoid the uſe of metallic oxides, as litharge, &c., which rot the ſtuff of the envelope; beſides that hydrogen gas, by gradually reducing the metals, corrodes ſuch varniſh, turning it black, and in time cauſing it to crack. The beſt method to prevent theſe inconveniences is to allow the oil to ſtand for ſeveral weeks over unſlaked lime, or to diſſolve in it a ſmall quantity of gum-ſandarac, gum-lac, maſtich, ſeed-lac, or common reſin; all of which, when finely powdered, may be diſſolved in linſeed oil by well boiling, thus communicating to the oil the property of drying, yet retaining elaſticity. Silk and canvas for umbrellas, &c. are varniſhed with a ſolution of either reſin or gum-lac, melted with drying linſeed oil to the conſiſtence of a thick balſam, ſo as not to run about: thus varniſhed they are very little heavier than before, though impermeable to air or water.

outſide

outſide is found preferable to the former method of giving an internal as well as an external coat. The compoſitions for varniſhing balloons * have been variouſly modified; but, upon the whole, the moſt approved appears to be the bird-lime varniſh of M. Faujas St. Fond, prepared after Mr. Cavallo's method as follows:

"In order to render linſeed oil drying, boil it, with two ounces of ſugar of lead and three ounces of litharge † for every pint of oil, till they are diſſolved, which may be in half an hour. Then put a pound of bird-lime and half a pint of the drying oil into an iron or copper veſſel whoſe capacity ſhould equal about a gallon, and let it boil very gently over a ſlow charcoal fire till the bird-lime ceaſes to crackle, which will be in about half or three quarters of an hour: then pour upon it two pints and a half more of the drying oil, and let it boil about an hour longer, ſtirring it frequently with an iron or wooden ſpatula. As the varniſh whilſt boiling, and eſpecially when nearly done, ſwells very much, care ſhould be taken to remove in thoſe caſes the pot from the fire, and replace it when the varniſh ſubſides; otherwiſe it will boil over. Whilſt the ſtuff is boiling the operator ſhould occaſionally examine whether it has boiled enough; which may be known by obſerving whether, when rubbed between two knives and then ſeparated from one another, the varniſh forms threads between them, as it muſt then be removed from the fire: when nearly cool, add about an equal quantity of ſpirit of turpentine: in uſing the varniſh, the ſtuff muſt be ſtretched and the varniſh lukewarm: in 24 hours it will be dry."

Every balloon ſhould be provided with a valve ſo conſtructed as to open inwards, having alſo a ſpring to keep it ſhut. The ſtring by which this valve is regulated muſt paſs through a ſmall hole in the lower part of the balloon to the car; its length muſt be ſuch as to allow ſeveral coils of it to remain in the boat: this is a requiſite precaution, as, when the inflammable air is much expanded, the horizontal diameter of the balloon is ſo much more extended, and its lower

* As the elaſtic gum, known by the name of Indian rubber, has been much extolled as a varniſh, the following method of making it, as practiſed by Mr. Blanchard, may not prove unacceptable:—Diſſolve elaſtic gum, cut ſmall, in five times its weight of rectified eſſential oil of turpentine, (ethereal ſpirit of turpentine of the ſhops,) by keeping them ſome days together; then boil one ounce of this ſolution in eight ounces of drying linſeed oil for a few minutes; ſtrain the ſolution, and uſe it warm.

† The metallic oxides are leſs exceptionable in the outer varniſh of a balloon than internally, as the firſt ſoaking in drying oil ſerves to ſhield the external varniſh from the action of the gas.

pole

pole conſequently drawn proportionably upwards, that the ſtring of the valve will be otherwiſe out of the traveller's reach; an accident which has frequently obliged them to climb up into the netting to regain it. The valve itſelf ſhould be covered with ſoft leather, reaching an inch or two beyond its edge every way. Its ſituation ſhould be upon the equator *, (and not, as generally directed, near the top,) elſe the lighteſt gas will be that which will eſcape; not to mention alſo the greater inconvenience in the latter caſe, ariſing from the eſtabliſhment of a complete current of atmoſpheric air through the balloon by the neck and valve together (the neck being generally left open a few inches), whereby a quantity of the lighter gas is carried off greater than one would imagine. To obviate this, the neck and valve ſhould never be both open at one time; and I apprehend the accidents frequently occaſioned by the uſually rapid deſcent and rebounding of a balloon, are to be attributed to an inattention to this precaution; the gas being violently carried out of the valve by a current of air running through the balloon, and this current increaſing with the velocity of the deſcent; ſo that, when the valve is again cloſed, the balloon is found to have decreaſed in levity much more than was wiſhed for.

The car for balloons may be left to the option of the amateur, remembering that light weight, and the property of floating if deſcending over water, be attended to.

[To be continued.]

LVII. *Extract from a Memoir on the Properties of Yttria Earth compared with thoſe of Glucine; on the Foſſils in which the former of theſe Earths is contained; and on the Diſcovery of a new Subſtance of a Metallic Nature.* By A. G. Ekeberg †.

THE firſt part of this memoir contains an account of ſome experiments, made by M. Ekeberg, to eſtabliſh the difference between glucine and the earth diſcovered in the gadolinite, and called yttria or gadoline; but as the peculiar nature of each of theſe earths is already well known

* The opening of the valve being ſometimes required during the rapid aſcenſion of a balloon, and being followed alſo by a quick deſcent, the equator is pointed out as the moſt proper ſituation in which to place the valve, to prevent the atmoſpheric air from ruſhing in either caſe into the balloon.

† From the *Tranſactions of the Academy of Sciences at Stockholm for* 1802, firſt quarter.

to

to chemiſts, it is here needleſs to repeat what has been already ſaid on that ſubject.

As the other is intereſting on account of its novelty, we ſhall lay before our readers the obſervations made on it by the author.

Though the mineral ſubſtance I diſcovered, ſays he, contains yttria, it could not be claſſed in a ſyſtem of mineralogy as a ſpecies of earth, on account of the more abundant mixture it contains of another ſubſtance equally remarkable, and which muſt increaſe the claſs of metals, already very numerous. I found this ſubſtance in two foſſils, obtained from different places: in one of them, it was united with iron and manganeſe; and in the other, with the former of theſe metals and gadoline.

This new metallic ſubſtance is diſtinguiſhed by its inſolubility in all acids. The only re-agent which has any action on it is cauſtic fixed alkali. When ſubjected to heat with this alkali, if the maſs be then lixiviated, it partly diſſolves in the water, and ſuffers itſelf to be precipitated from that ſolution, by means of an acid—but without the precipitate being in any manner attacked, whatever be the quantity of the acid employed. When ſeparated by the filter, and dried, it remains under the form of an exceedingly fine white powder, which does not change its colour even at a red heat. If the remaining maſs be treated with acids, the ſame powder is obtained. Its ſpecific gravity, after being brought to red heat, is 6·500. It is fuſible by the blowpipe, by the addition of alkaline phoſphate and borate of ſoda, but communicates no colour to the flux.

Expoſed to a ſtrong heat in a crucible, without any other mixture than pounded charcoal, it is reduced to a button moderately hard, having ſome metallic ſplendour at its ſurface, but a dull blackiſh fracture. Acids have no other action on this kind of regulus, but that of bringing it to the ſtate of white oxide in which it was before. The circumſtances of the reduction, as well as the ſpecific gravity of this ſingular ſubſtance, ſeem to aſſign it a place among the metals, and I have ſufficient reaſons for being perſuaded that it is none of thoſe already known. The ſubſtances with which it might be confounded are the oxides of tin, tungſten, and titanium, which are ſoluble in cauſtic alkalies, and which, under ſome circumſtances, reſiſt acids. But the oxide of tin is eaſily diſſolved and reduced: tungſten immediately diſcovers itſelf by its ſolubility in ammonia, and by the blue colour which it communicates to phoſphate

phate of foda: the oxide of titanium gives a hyacinth colour to borax, and becomes foluble in acids by fufion with carbonate of potafh*.

Before I defcribe the chemical analyfis which I undertook of the two fubftances, which I confider as ores of the new metal, it is proper I fhould give a defcription of their external characters. In order to avoid circumlocution, when neceffary to name them I fhall venture to give them a generic denomination. Taking advantage of the ufage which admits mythologic appellations, and to expref the property which the new metal has, of not becoming faturated with the acids in which it is immerfed, I fhall apply to it the name of *Tantalus*. For the ore compofed of tantalus, iron and manganefe I propofe the name of *tantalite*; and for the ore containing yttria, that of *yttrotantalite*, which will not be found longer than that of *fiderotitanite*.

The fpecimen of tantalite was given to me by M. Geeger, director of the mines; who affured me that this fubftance has been known fince 1746, and confidered as a problematic variety of the garnet of tin, (*zinngraupen.*) It is found near the farm of Brokaern, in the parifh of Kimito, and government of Abo, in Finland, in a large mountain on the borders of the Baltic. The matrix is compofed of white quartz and mica, with veins of red feldfpar in large laminæ, matters of which the fides of the vein are formed: the titanite is found difperfed throughout it, in the form of garnet.

What I faw was in detached cryftals, of the fize of a walnut, and the beft defined feemed to approach the octhaedral form; they were charged with parcels of feldfpar and mica.

Its furface is fmooth, fhining, and blackifh.

Its fracture is compact, and has a certain metallic fplendour: the colour of the fracture is not every where the fame; it varies between grayifh blue and the black of iron.

When powdered, it is blackifh gray inclining a little to brown.

It has fufficient hardnefs to ftrike fire with ftcel.

I have not obferved that it has any attraction for the magnet.

Its fpecific gravity is 7·953.

The yttrotantalus is found in the fame place and in the fame matrix as the gadolinite. Klaproth fays that the latter

* I had, however, entertained fome fufpicions in regard to the identity of the new fubftance and the laft-mentioned metal; and I was not fully convinced of its not exifting, but by comparing it with the titanized iron of Norway, which I decompofed for that purpofe.

is

is found incruſted in a granitic maſs: but though the conſtituent parts of granite are found there from time to time, it is no leſs certain that the real matrix is nothing elſe than feldſpar, as is evidently ſeen in the large mine of Ytterley. The mica and quartz found there form diſtinct parts, and do not enter into combination with the feldſpar*; but in general it is a rock of feldſpar, interſected by large veins of mica, in a direction almoſt perpendicular; and it is in the proximity of theſe veins that the gadolinite as well as the yttrotantalus muſt be ſought for. The firſt is generally found attached on one ſide to a vein of argenteous mica, and the reſt of its volume enveloped by feldſpar. The ſecond never adheres immediately to the mica. The clumps (*rognons*) which it forms, become enveloped with a thin cruſt of feldſpar, ſeparate from the grand maſs by thin ſtrata of graviſh black mica. The veins charged with theſe *rognons* are rarely inſulated; ſeveral of them are found together, ſeparated only from each other, and from the principal rock, by ſimilar ſides of mica. It was thus that I for the moſt part found theſe ſubſtances placed by nature, and it is very rarely that they are found in grains diſſeminated throughout the rock of feldſpar.

The largeſt *rognons* which I found of the ore of the yttrotantalus had not attained to the ſize of a walnut. The fracture of them was granulated, of an iron black colour, with a metallic ſplendour.

Its hardneſs is not conſiderable; it can be ſcraped by means of a knife, but with difficulty.

When powdered it is of a graviſh colour.

It exerciſes no action on the magnet.

I found its ſpecific gravity to be 5·130; but as it was not poſſible for me to find a piece entirely free from feldſpar, I ſuſpected that its real gravity muſt be a little more conſiderable.

We ſhall terminate this extract by a ſhort view of that part of M. Ekeberg's memoir, which relates to the analyſis of the gadolinite, and the compariſon of the yttria with glucine, which in ſeveral works has been conſidered as being of the ſame nature.

Gadolinite, when pure, is ſufficiently compact to ſtrike fire with ſteel.

It is found cryſtallized in an imperfect manner, like ſome kinds of garnets.

It contains glucine.

* I ſpeak here only of the maſſes of the principal rock, without denying the poſſibility of finding there ſome fragments in which the three ſubſtances are intermixed.

Beſides

Beſides the diſtinctions eſtabliſhed by Klaproth and Vauquelin between the gadoline and glucine, theſe two earths appear to be different by the following peculiar properties:

The ſpecific gravity of gadoline differs conſiderably from that of glucine, which is only 2·967, while that of gadoline is 4·842. The laſt earth is the heavieſt of all the earthy ſubſtances known, ſince it ſurpaſſes by 0·482 the gravity of barytes, which weighs only 4·000.

It is ſoluble in alkaline carbonates.

It is abſolutely inſoluble in cauſtic alkalies.

It is not, like glucine, precipitated by ſuccinates.

LVIII. *Obſervations on the Change which Carbonic Acid Gas experiences by the Electric Spark, and on the Decompoſition of the ſame Gas by Hydrogen Gas.* By THEODORE DE SAUSSURE*.

I. *Change which Carbonic Acid Gas experiences by the Electric Spark.*

DR. PRIESTLEY had obſerved that carbonic acid gas dilated by the electric ſpark, and experienced a modification which prevented it from being entirely abſorbed by lime water, or by alkalies. C. Monge examined with the greateſt care what took place in this experiment, and found that the gas produced by electriſation was inflammable gas. I ſhall here deſcribe in a few words the principal reſults of this obſervation: A column of carbonic acid gas, of 34 inches, contained by mercury, roſe to 35 inches and a half, after having been traverſed for a long time by electric ſparks, which circulated between iron conductors. It could not be dilated any more by further electriſation. The wires as well as the mercury were oxidated. Potaſh could only abſorb 21 inches and a half of this column of acid gas: the remaining 14 inches were inflammable gas. C. Monge accounts for theſe phænomena by ſuppoſing that the carbonic acid gas does not experience the leaſt alteration in its principles, and he reaſons nearly as follows: The conductors and the mercury, by decompoſing the water held in ſolution in the carbonic acid gas, produce two oppoſite effects, of which nothing is obſerved but the difference. 1ſt. The volume of the acid gas is diminiſhed, by being deprived of the water which it held in ſolution. 2d. The volume of the elaſtic fluid is augmented, by the development of the hydrogen gas of the water de-

* From the *Journal des Mines*, No. 68.

compoſed:

compoſed. The reſiduums of gas after the operation are a mixture of hydrogen gas, reſulting from the decompoſition of the water, and carbonic acid gas deprived of water.

This very ingenious explanation* was without doubt the only one which could preſent itſelf at the time when it was given. Had it been juſt, it would have been neceſſary, by reſtoring to the acid gas condenſed by deſiccation the water it had loſt, to dilate it again, and to augment about 12 inches the column in queſtion. As C. Monge did not ſubmit his explanation to this deciſive proof, I thought proper to attempt it.

I cauſed to circulate for 18 hours electric ſparks in the bulb of a matraſs which contained 13 cubic inches of pure carbonic acid gas, and without any mixture of water ſuperabundant to that which it might naturally hold in ſolution. The mercury, in which the inverted matraſs was immerſed, roſe to about the half of its neck. After electriſation, the metallic fluid was found oxidated black, as had been obſerved by Monge and Prieſtley; but my conductors, which were of copper, were not ſenſibly altered. The elaſtic fluid had experienced a ſmall dilatation, which appeared to me not to exceed the tenth part of a cubic inch. I then made about a grain of water† to paſs in contact with the aeriform gas contained in the matraſs. I let it remain there for ſeveral days, without perceiving any dilatation in the volume of the gaſes, the reſidua of the operation. I then moiſtened, with a drop of water which I introduced, the whole inſide of the matraſs—but in vain—the mercury conſtantly remained at the ſame height. I however found, on abſorbing by potaſh the reſiduum of the acid gas, that a cubic inch of carbonic acid gas had diſappeared, and had been replaced by a quantity nearly equal, or rather ſuperior, to the inflammable gas. The 20 cubic centimetres occupied in the neck of the matraſs a column four inches in length; and the acid gas, had the ſuppoſed explanation been juſt, would have been dilated

* It ſuppoſes that the carbonic acid gas may hold in ſolution a great quantity of water. But this aſſertion is not proved by any other direct experiment. Dr. Prieſtley was not able to calcine carbonate of barytes but by the help of a current of aqueous vapour, which he cauſed to circulate on that earth brought to a red heat. This reſult may be explained by the affinity alone of the water for the barytes. It is beſides poſſible that the carbonic acid gas diſſolves at a red heat a certain quantity of water, and dilates much in this ſolution, without producing theſe effects at the temperature of the atmoſphere.

† It is needleſs to obſerve here, that water can abſorb no more than its own volume of acid gas with the preſſure of the atmoſphere, and that the drop of water introduced into the matraſs could not produce by this abſorption any ſenſible change in the volume of the elaſtic fluid.

through all that ſpace. I then thought that this inflammable gas did not ariſe from the decompoſition of the water, but from that of the carbonic acid itſelf by the metal. I indeed found that this gas was not hydrogen gas, but carbonous gas perfectly pure. I burnt 100 parts of it on mercury, with about a third of oxygen gas. I did not perceive water after this combuſtion, which left for reſiduum 77 parts of carbonic acid gas.

The dilatation which the latter experiences by electriſation may be explained by the different denſities of the carbonous gas and the carbonic acid gas. I was not able to verify the obſervation of C. Monge reſpecting the dilatation experienced by the carbonic acid gas, after electriſation over mercury.

If it was not poſſible to reduce entirely the acid gas into carbonous gas by theſe proceſſes, it was becauſe the firſt ſtrata of metallic oxidation preſented an obſtacle to further oxidation, by preventing the points of contact. The development of the carbonous gas produced therefore an analogous effect.

It reſults then from my obſervations, that the change which carbonic acid gas undergoes by electriſation does not ariſe from the decompoſition of the water, but from the partial decompoſition of the carbonic acid gas, which becomes carbonous gas, giving up a part of its oxygen to the metal introduced in theſe experiments.

II. *Decompoſition of Carbonic Acid Gas by Hydrogen Gas.*

It was long ſuppoſed that carbonic acid gas could be decompoſed by hydrogen gas; but no one was able to effect it, though many experiments were made on that ſubject. I had obſerved, that a mixture of equal parts of hydrogen gas and carbonic acid gas, contained by mercury and left to itſelf, had decreaſed in volume in the courſe of a year. When I then cauſed the reſiduum of acid gas to be abſorbed by potaſh, and had burnt the hydrogen gas, I found that there was formed in this combuſtion carbonic acid gas: but theſe reſults were not very ſenſible; and what took place in this operation was to me mere conjecture. Since that time I have been able to confirm in a deciſive manner this firſt obſervation, by cauſing the electric ſparks to circulate in a mixture of carbonic acid gas and hydrogen gas. In a few moments I ſaw the volume of the gas decreaſe, drops of water formed, and the acid gas paſs almoſt entirely to the ſtate of carbonous gas. The following are the details of one of theſe experiments: I introduced into a cylindric glaſs jar

about nine lines in diameter, and closed by mercury, a mixture of four parts in volume of carbonic acid gas, and three parts of hydrogen gas. The space occupied by the two aëriform fluids united formed a long column of seven inches, so that each part in volume of the glass corresponded to one inch in length of the column. I caused the electric spark to circulate by iron conductors. The condensation of the gas, which at first took place very rapidly, became always slower; after twelve hours electrisation, its progress was almost insensible. The very fine drops of water, formed during the operation in the upper part of the tube, disturbed its transparency. The column of aëriform fluid was reduced to four inches. It then experienced in its length a diminution equal to three inches. I then introduced into it potash, which could absorb only one inch of carbonic acid gas. The three remaining inches were carbonous gas almost pure. I burned by means of the electric spark, 100 parts of it with oxygen gas, and they left for residuum 64 parts of carbonic acid gas.

It is seen, then, that three inches of carbonic acid gas were decomposed, and passed to the state of carbonous gas, by combining a part of their oxygen with the hydrogen gas introduced. It is seen also that the latter, by losing the elastic state to form part of the water resulting from this combination, produced the condensation observed in the volume of the two gases.

It is to be remarked, that the mercury and conductors in this experiment were not considerably oxidated.

It has long been observed, that hydrogen gas, confined by water in contact with atmospheric air, decreases very slowly in volume, and then burns with a flame less vivid. It has been supposed that this gas filters through the water in the atmosphere; but there is nothing to support this explanation. In my opinion, it is more probable that the carbonic acid gas of the atmosphere filters alone through the water, according as it is decomposed by the hydrogen gas, which decreases in the ratio of this decomposition.

LIX. *Some Account of* Richard Kirwan, *Esq. LL. D. F. R. S. and P. R. I. A.*

THIS gentleman, who has distinguished himself so much by his philosophical and geological labours, was bred to the law, and exercised his profession as a barrister, till infirm health, and the death of his elder brother, a member of the Irish parliament, occasioned him to become an experimental

inquirer into the phænomena of nature. Having devoted his attention to chemistry and natural philosophy, he set out in this new mode of life, in or near London, about the year 1779 or 1780. He made his debut with some papers read in the Royal Society, for which he received the Copley medal, about the year 1781. The titles of these papers are as follow:—Experiments and Observations on the Specific Gravities and Attractive Powers of various Saline Substances: read Nov. 16, 1780.—Continuation of these Experiments and Observations: read April 11, 1782.—Conclusion of the Experiments and Observations concerning the Attractive Powers of the Mineral Acids: read Dec. 12, 1782.—Remarks on Mr. Cavendish's Experiments on Air: read Feb. 5, 1784.—Remarks on Specific Gravities, taken at different Degrees of Heat; and an easy Method of reducing them to a common Standard: read Feb. 17, 1785.—Experiments on Hepatic Air: read Dec. 22, 1785.

Mr. Kirwan returned to his native country about the year 1789, and some time after was appointed President of the Royal Irish Academy; a place which he continues to hold, with honour to himself and advantage to the philosophical world. The papers with which he has enriched the Transactions of the learned body over which he presides are: An Essay on the Variations of the Barometer: read March 1, 1788.—Observations on Coal Mines: read Jan. 10, 1789.—Experiments on the Alkaline Substances used in Bleaching; and on the Colouring Matter of Linen Yarn: read April 4, 1789.—On the Strength of Acids and the Proportion of Ingredients in Neutral Salts: read Dec. 24, 1790.—A Comparative View of Meteorological Observations made in Ireland since the Year 1788, with some Hints towards forming Prognostics of the Weather: read Feb. 2, 1793.—Reflections on Meteorological Tables, ascertaining the precise Signification of the Terms Wet, Dry, and Variable: read July 23, 1793.—State of the Weather in Dublin from the 1st of June 1791 to the 1st of June 1793.—Examination of the supposed Igneous Origin of Stony Substances: read Feb. 3, 1793.—Essay in Answer to the following Question, proposed by the Royal Irish Academy: What are the Manures most advantageously applicable to the various Sorts of Soils, and what are the Causes of their beneficial Effect in each particular Instance? read Jan. 4, 1794.—Meteorological Observations made in Ireland in the Year 1793: read Jan. 25, 1794.—Experiments on a New Earth found near Stronthian in Scotland: read Jan. 9, 1794.—Of the Composition and Proportion of Carbon in Bitumens and Mineral Coal: read Dec. 19,

1795.—Synoptical View of the State of the Weather in Dublin: read Jan. 9, 1796.—Thoughts on Magnetiſm: read March 19, 796.—On the Primitive State of the Globe, and its ſubſequent Cataſtrophe: read Nov 19, 1796.—Synoptical View of the State of the Weather at Dublin in the Year 1796.—Synoptical View of the State of the Weather at Dublin in the Year 1797.—Additional Obſervations on the Proportion of real Acid in the three antient known Mineral Acids, and on the Ingredients in various Neutral Salts and other Compounds: read Dec. 16, 1797.—Eſſay on Human Liberty: read July 28, 1798.—Synoptical View of the State of the Weather at Dublin in the Year 1798.—Synoptical View of the State of the Weather at Dublin in the Year 1799.—Obſervations on the Proofs of the Huttonian Theory of the Earth, adduced by Sir James Hall: read Feb. 8, 1800.—An Illuſtration and Confirmation of ſome Facts mentioned in an Eſſay on the Primitive State of the Globe: read May 5, 1800.—An Eſſay on the Declivities of Mountains: read April 28, 1800.—Of Chemical and Mineralogical Nomenclature: read March 24, 1800.—Remarks on ſome Sceptical Poſitions in Mr. Hume's Inquiry concerning the Human Underſtanding, and his Treatiſe of Human Nature: read October 20, 1800.—Synoptical View of the State of the Weather at Dublin in the Year 1800.—Of the Variations of the Atmoſphere: read May 11, 1801.—Synoptical View of the State of the Weather at Dublin in the Year 1801.

Mr. Kirwan is alſo the author of the following works: Eſſay on Phlogiſton; Elements of Mineralogy, 2 vols.; Geological Eſſays; Eſſay on the Analyſis of Mineral Waters; and (in the preſent volume) A Reply to Mr. Playfair's Reflections on Mr. Kirwan's Refutation of the Huttonian Theory of the Earth; and an Illuſtration and Confirmation of ſome Facts mentioned in an Eſſay on the Primitive State of the Globe.

LX. *Obſervations on the Law of the Expanſion of Water at Temperatures below 42°; extracted from a Paper on the Power of Fluids to conduct Heat.* By JOHN DALTON*.

MY firſt attempt was to aſcertain the preciſe degree of cold at which water ceaſes to be further condenſed, and likewiſe how much it expands in cooling below that degree to the temperature of freezing, or 32°. For this purpoſe I took a thermometer tube, ſuch as would have given a ſcale of 10

* From *Journals of the Royal Inſtitution of Great Britain.*

inches with mercury from 32° to 212°, and filled it with pure water. I then graduated it by an accurate mercurial thermometer, putting them together into a baſon filled with water of various degrees of heat, and ſtirring it occaſionally. As it is well known that water does not expand in proportion to its heat, it does not therefore afford a thermometric ſcale of equal parts, like quickſilver.

From repeated trials agreeing in the reſult, I find that the water thermometer is at the loweſt point of the ſcale it is capable of, that is, water is of the greateſt denſity, at 42½° of the mercurial thermometer. From 41° to 44° incluſively the variation is ſo ſmall as to be juſt perceptible on the ſcale; but above or below thoſe degrees the expanſion has an increaſing ratio, and at 32° it amounts to 1-8th of an inch, or about $\frac{1}{72}$th part of the whole expanſion from 42½° to 212°, or boiling heat. During the inveſtigation of this ſubject, my attention was arreſted by the circumſtance, that the expanſion of water was the ſame for any number of degrees from the point of greateſt condenſation, no matter whether above or below it: thus, I found that 32°, which are 10½° below the point of greateſt denſity, agreed exactly with 53°, which are 10½° above the ſaid point; and ſo did all the intermediate degrees on both ſides. Conſequently, when the water thermometer ſtood at 53°, it was impoſſible to ſay, without a knowledge of other circumſtances, whether its temperature was really 53° or 32°. Recollecting ſome experiments of Dr. Blagden in the Philoſophical Tranſactions, from which it appears that water was cooled down to 21° or 22° without freezing, I was curious to ſee how far this law of expanſion would continue below the freezing point, previouſly to the congelation of the water, and therefore ventured to put the water thermometer into a mixture of ſnow and ſalt, about 25° below the freezing point, expecting the bulb to be burſt when the ſudden congelation took place. After taking it out of a mixture of ſnow and water, where it ſtood at 32° (that is 53° per ſcale), I immerſed it into the cold mixture; when it roſe, at firſt ſlowly, but increaſing in velocity, it paſſed 60°, 70°, and was going up towards 80°, when I took it out to ſee if there was any ice in the bulb—but it remained perfectly tranſparent. I immerſed it again and raiſed it to 75° per ſcale, when in an inſtant it darted up to 128°; and that moment taking it out, the bulb appeared white and opaque, the water within being frozen. Fortunately it was not burſt; and the liquid which was raiſed thus to the top of the ſcale was not thrown out, though the tube was unſealed. Upon applying the hand, the ice was melted, and the liquid reſumed its ſtation.

This

This experiment was repeated and varied, at the expenſe of ſeveral thermometer bulbs; and it appeared that water may be cooled down in ſuch circumſtances, not only to 21°, but to 5 or 6°, without freezing, and that the law of expanſion above mentioned obtains in every part of the ſcale from $42\frac{1}{2}$° to 10° or below; ſo that the denſity of water at 10° is equal to the denſity at 75°.

LXI. *Remarks on certain Properties of Barytes in its Combination with Mineral Acids; and on two new Salts never before deſcribed.* *By* J. HUME, *Eſq.**

FROM a number of experiments I have occaſionally made on *barytes*, but chiefly on it when combined with mineral acids, I have been led to draw ſome concluſions and obſerve phænomena, which, I believe, have hitherto been either totally unknown, or ſo very imperfectly detailed, as, no doubt, to have frequently been a ſource of error. This earth, for I am not yet diſpoſed to claſs it with alkalies, certainly poſſeſſes peculiar habitudes, or rather, when compared with thoſe of other earths and alkalies, and its own combinations compared with each other, ſome ſingular anomalies, which I have never yet ſeen pointed out by chemical writers. Amongſt many others, the following appear the moſt prominent, and therefore demand firſt to be noticed.

1. That ſulphate of barytes is completely *ſoluble* in ſulphuric acid; forming a ſaline *fluid* or acidulous ſulphate, analogous, in ſome of its characters, to phoſphate of lime and many other ſalts, with capacity for exceſs of acid; decompoſable by water alone, which returns it to ſimple ſulphate; and this ſalt never has been enumerated by any author.

2. That carbonate of barytes is alſo totally decompoſed by, and ſoluble in, ſulphuric acid, forming, of courſe, the ſame *acidulous* ſulphate. Reſpecting any figure this new ſalt may put on, I have not yet been able fully to determine; but I ſtrongly ſuſpect it may, under particular circumſtances, be made to cryſtallize.

3. That nitrate of barytes, not in cryſtals only, but even a ſaturated aqueous ſolution, is perfectly *inſoluble* in nitrous acid of the uſual ſpecific gravity.

4. That carbonate of barytes may entirely be changed into nitrate by nitrous acid in its *concentrated* ſtate. The converſe of this has hitherto been maintained.

* Communicated by the Author.

5. That muriate of barytes is virtually *infoluble* in muriatic acid.

6. That carbonate of barytes may be rendered into muriate by *concentrated muriatic acid.*

7. This may not appear to be, with propriety, placed after the others; it ought nevertheleſs to be named, ſince no author has given any account of it. It is, that ſulphate of ſtrontian has alſo a capacity for ſuper-ſaturation; forming, like No. 1, an acidulous ſulphate in *ſolution*, and decompoſable by water.

In ſeveral chemical works, written by very eminent men, I have frequently obſerved ſome of the above reſults very nearly accompliſhed; and have been amazed to find ſuch palpable truths had eſcaped their notice: yet, on a careful examination of the context, I confeſs, I could never find a ſingle proof that any one of theſe peculiarities of barytes has been known to the full extent as above detailed. In reſpect to No. 1, there is no mention of an *acidulous* ſulphate nor of *fluidity*, in an eſſay, where I expected to find it, written in 1790 by C. Fourcroy *. It may alſo be remarked, that in a more modern work by the ſame very excellent chemiſt, ſpeaking of ſulphate of barytes, he expreſſes himſelf thus: "Il paraît cependant diſſoluble par des *moyens* que la nature nous *cache* encore, puiſqu'il eſt viſiblement criſtalliſé par l'eau. On ne peut pas le faire criſtalliſer artificiellement †." The ſame author had affirmed the perfect inſolubility of carbonate of barytes in nitrous (or nitric, for it is not yet decided) acid: "L'acide nitrique le plus concentré n'a abſolument aucune action ſur le carbonate de barite natif en morceau, ce ſel y reſte intact abſolument comme dans l'eau ‡." This is quite contrary to the reſult of my experiments, even with little more heat being employed than the common atmoſpheric temperature. Indeed, regarding the effect of mineral acids upon the native carbonate of witherite, for it would be unfair, in this place, to ſpeak of *artificial* carbonate, the ſame author ſums up his opinion in one ſentence: "Que les acides ne l'attaquent point en maſſe, et lorſqu' ils ſont concentrés §." Since no part of this analyſis has yet been re-

* Analyſe de Carbonate de Baryte natif, &c. § 3.

† Syſtème des Conn. Chimique.—"It, however, appears to be ſoluble by *means* which nature ſtill *conceals* from us, ſince it is evidently cryſtallized by water. It cannot be made to cryſtallize artificially."

‡ Ibid. "The moſt highly concentrated nitric acid has abſolutely no action on native carbonate of barytes in bits. This ſalt remains in it abſolutely unattacked, as in water."

§ Analyſe, &c. § 4.—"That the acids do not attack it in a maſs, and when they are concentrated."

tracted,

tracted, but, on the contrary, if poſſible, more completely confirmed by the author's writings ſince that period, I have been leſs ſcrupulous in applying theſe quotations to my purpoſe. Though another author has, in one ſolitary ſentence, apparently flatly contradicted C. Fourcroy, yet, on a cloſer inſpection of the work, (2de édition *conſid rablement augmentée*,) which I ſhould call a *third* edition, it does not appear that any one of theſe habitudes or anomalies has been clearly demonſtrated to exiſt. The ſentence is, to ſay no more of it, evidently conditional, and no mention made either of *concentration* or *dilution*: "Tous les acides minéraux decompoſent ce ſel," (*meaning* carbonate de barite *.) But my doubts were completely removed, at leaſt reſpecting what I have ſtated at Nos. 3 and 4, when I read a whole page †, where we find detailed a moſt circuitous proceſs for purifying nitrous acid by litharge and nitrate of ſilver.

I purpoſely forbear to mention any method I purſued to accompliſh each combination; as it appears to me to be within the limits of the meaneſt capacity, and obvious to every chemiſt to obtain the ſame reſults.

No. 108, Long Acre,
January 24, 1803.

LXII. *On the Utility of Pruſſiate of Copper as a Pigment.* By Charles Hatchett, *Eſq. F. R. S.* ‡

THE accidental diſcovery made by Dieſbach of the pigment called Berlin or Pruſſian blue, about the year 1710, and which afterwards was publiſhed by Woodward in the Philoſophical Tranſactions for 1724, was ſoon adopted by artiſts and manufacturers, ſo that in a ſhort time the great utility of this colour was completely eſtabliſhed: it is therefore remarkable, that but little attention has been ſubſequently paid to the colorific properties of the other metallic pruſſiates.

The experiments made by Mr. Brown with the pruſſic lixivium on various metallic ſolutions do not merit particular attention, as the reſults evidently ſhow that a very large portion of the alkali remained unſaturated with pruſſic acid, and thus the effects appeared different when the lixivium was prepared with blood or with muſcle §.

Bergman has, however, more accurately examined the pro-

* Analyſe, &c. § 7.—"All the mineral acids decompoſe this ſalt."
† Manuel d'un Cours de Chimie, *La Grange*.
‡ From Journals of the Royal Inſtitution of Great Britain.
§ Philoſophical Tranſactions 1724, p. 17.

perties of metallic precipitates, (Opuſcula, tom. ii. p. 385), and eſpecially notices the various colours of the pruſſiates; but neither he nor any other chemiſt, as far as I am acquainted, has pointed out to artiſts the utility of pruſſiate of copper as a pigment. During ſome late experiments, I was much ſtruck with the beauty of this precipitate, and was therefore induced to make ſeveral trials of it as a paint: the reſults exceeded my moſt ſanguine expectations. I afterwards prepared a large quantity, which at my requeſt ſeveral gentlemen (particularly B. Weſt, eſq. P.R.A., John Trumbull, eſq., and ſir H. C. Engleſield,) were ſo obliging as to try in oil, and in water; and I have had the ſatisfaction to learn, that in beauty and intenſity it ſurpaſſes every brown paint now in uſe, with the additional advantage, that, by reaſon of its purple tint, it forms with white various ſhades of bloom or lilac colour, which do not appear liable to fade like thoſe which are formed by means of lake.

The pruſſiates obtained from acetite, ſulphate, nitrate, and muriate of copper, are all very beautiful; but the fineſt and deepeſt colour is afforded by the muriate. I have found alſo that pruſſiate of lime can be better depended upon for this purpoſe than pruſſiate of potaſh. The beſt mode, therefore, of forming this pigment, is to take green muriate of copper, diluted with about ten parts of diſtilled or rain water, and to pour in pruſſiate of lime until the whole is precipitated: the pruſſiate of copper is then to be well waſhed with cold water on the filter, and to be dried without heat.

LXIII. *Proceedings of Learned Societies.*

ROYAL SOCIETY OF LONDON.

AN account of a journey to the ſummit of Whararai, a mountain in the iſland of Owhyhee, by Mr. Archibald Menzies, naturaliſt on board the Diſcovery, captain Vancouver, was read on the 9th and 16th of December.

In January 1799, the Diſcovery, being ſtationed in Karakakooa bay, Mr. Menzies was deſirous of making a botanical excurſion into the iſland of Owhyhee, in company with ſome other gentlemen of the expedition, and, in particular, of aſcending a conical mountain in the neighbourhood, called Whararai. For this purpoſe he was furniſhed with a numerous company of attendants by the king of the iſland, under the command of one of the chiefs, who was made reſponſible for his ſafety, and for his perfect accommodation with proviſions of all kinds, and who executed his taſk with as much fidelity

fidelity as the whole troop performed their labours with alacrity. Mr. Menzies had a portable barometer of a ſimple conſtruction, by which he aſcertained the height of different places as accurately as the time would allow. The iſland appeared to be in general in a ſtate of high cultivation: the proviſions for the journey conſiſted of live hogs, poultry, dried fiſh, yams, and cocoa-nuts, in quantities that loaded more than twenty men. They left the ſea-ſide the 17th of January, after coming by water to the foot of the mountain, the barometer ſtanding at 30·10, the thermometer at 81°, at noon. The road was through lava and other volcanic productions for about three miles: here the plantations of bread-fruit trees began, and the country was fertile and pleaſant; the night was paſſed in the uppermoſt village, conſiſting of a few ſcattered huts. Beyond this was a thick foreſt, ſkirted by fruitful plantations of bananas and plantains: about three miles within the foreſt, the elevation appeared to be 2600 feet above the ſea. The thermometer was 59°, at noon. The natives conſtructed a number of ſmall huts, which afforded ſhelter to the whole party for the night at the upper extremity of the foreſt. Here the thermometer was at 58°, in the evening: the uniformity of temperature at heights conſiderably different, Mr. Menzies attributes to the ſhelter of the foreſt, and the evaporation from the trees. But the next morning the thermometer was at 43°. The ſummit of the mountain was rugged and barren: Mr. Menzies arrived at it in a few hours from the laſt ſtation. It afforded a very extenſive view of the iſland, although parts of it were hidden by clouds: its moſt conſpicuous features were two other mountains, of which the ſummits are covered with perpetual ſnow, bearing E.N.E. and S.E. by E. of Whararai. On this hill there is a very deep crater of a volcano, with aſhes and cinders appearing quite freſh: the natives conſider it as the habitation of evil ſpirits, whom they attempt to pacify by offerings of various kinds. The party of travellers ſpent the whole of this and the following day on the mountain, and paſſed the night in caverns thatched with plantain leaves, and ſtrewed with graſs and mats for the occaſion. The ſophora tetraptera was in flower, as a ſmall ſhrub; in the lower parts of the iſland it becomes a tree, of which the natives make their ſpears, and which takes a fine poliſh. The dodonæa viſcoſa thrived on the ſummit of the hill; and a ſmall ſhrubby geranium was found there. The height appeared to be 8000 feet above the ſea. The thermometer was lower at ſun-ſet than at ſeven in the morning.

Mr. Menzies deſcended on the ſouth-eaſt ſide of the hill, and

and arrived in the afternoon at a deep cavern, where he paſſed the night. Hence he made a fruitleſs attempt to aſcend the ſnow-clad mountain, on the other ſide of the valley, in which the natives accompanied him with the greateſt reluctance: the ſame cavern received him the following night. The centre of the iſland between the three mountains is barren and uninhabited: it appears to be elevated about 5000 feet above the ſea. Returning towards the ſhore, the party arrived the next evening at a village nine or ten miles from Karakakooa bay, ſurrounded by fields and plantations in the higheſt poſſible ſtate of cultivation; its elevation appeared to be about 2000 feet. Here they were entertained by an exhibition of much grace and great activity in the performance of a female dancer belonging to a ſtrolling party. The next day was the laſt of the excurſion; and the natives were diſmiſſed with rewards of knives, files, ſciſſars, looking-glaſſes, and tape, of which a ſmall portion was ſurrendered by each to the king. The barometer now ſtood at 30·12, and the thermometer at 74°.

On the 13th of January the Society reſumed its ſittings after the Chriſtmas holidays. An intereſting paper, by Charles Hatchett, eſq. on the alloying of metals, was read on that evening, and continued on the evening of the 23d. It reſults from his experiments that platina ſhould not be employed as an alloy for gold, as it makes the gold aſſume a white colour. A number of experiments were made with pieces of gold coin, to aſcertain the effects of the exceſs of motions ſimilar to what they experience by rubbing in the pocket, and by being tranſported from one place to another. By theſe it was found, that copper in the proportion of 1-12th was the beſt alloy for gold; and that the deficiency found of late in the gold coin was not owing to the wear of circulation, as, in a quantity of guineas rather looſely packed, and ſent to ſome diſtance by the coach, the wear was all upon a few, and on thoſe the impreſſion was quite obliterated: yet they were not found much deficient in weight, the work being by the action preſſed in, and not as it were filed off.

ROYAL SOCIETY OF EDINBURGH.

This learned body has publiſhed the ſecond part of the fifth volume of its Tranſactions, which preſents the following papers:—Remarks on a mixed Species of Evidence in Matters of Hiſtory; with an Examination of a new Hiſtorical Hypotheſis in the *Mémoires pour la Vie de Petrarque:* by the Abbé de Sade: by Alexander Fraſer Tytler, eſq.—Deſcription of an Extra-uterine Fœtus; by Mr. Thomas Blizzard.

zard.—Meteorological Abſtract for the Years 1797, 1798, and 1799; by Mr. Playfair.—A new and univerſal Solution of Kepler's Problem; by James Ivory, Eſq.—Deſcription of ſome Improvements in the Arms and Accoutrements of Light Cavalry, &c.; by the Earl of Ancrum.—A new Method of expreſſing the Co-efficients of the Development of the Algebraic Formula $(a^2 + b^2 - 2ab \cos. \varphi)^n$, by means of the Perimeters of two Ellipſes, when n denotes the half of any odd Number; with an Appendix, containing the Inveſtigation of a Formula for the Rectification of any Arch of an Ellipſe: by Mr. William Wallace.—Chemical Analyſis of an uncommon Species of Zeolite; by Dr. Robert Kennedy.

ROYAL SOCIETY OF GOTTINGEN.

The following prize queſtion has been propoſed for the year 1804:

As many obſervations and theories reſpecting the nature, principles, and laws of atmoſpheric phænomena, which if ſubjected to proof and more accurately known might be of great importance and utility in improving the preſent ſyſtem of meteorology, are contained in the works of the old and modern naturaliſts of the 16th century, the Society requires a hiſtory of meteorology from the time of the Greeks and Romans to the preſent period, drawn from authentic ſources, and materials ſelected with critical attention to the object in view. The prize will be 50 ducats, and the papers muſt be tranſmitted to the ſociety before the month of September of the above year.

LXIV. *Intelligence and Miſcellaneous Articles.*

FROM PROFESSOR PICTET.

Paris, January 1, 1803.

PROFESSOR PICTET preſents his moſt ſincere reſpects to Mr. Tilloch, and embraces the opportunity of a friend to ſend him one or two communications, which may prove intereſting.

In the ſitting of the National Inſtitute of December 29, a letter was read from M. Mollet, profeſſor of natural philoſophy at Lyons, in which he announced two facts which appear to be new. The firſt is the appearance of a ſmall light in the air which ſurrounds the orifice of an air-gun when

when discharged in the dark. This experiment does not always succeed; and the cause of the differences observed in this respect is not yet known.

The second fact is the inflammation of any combustible matter, such as a small bit of linen rolled up, when put into the narrow canal in which the lower extremity of a pump for condensing the air generally terminates. Two or three strokes of the piston are sufficient to inflame it, according as the current of air produced is more or less rapid.

In the same sitting M. Seguin concluded a memoir, which he had announced in the preceding, on the discovery he pretends to have made of a new febrifuge principle, absolutely different from any of those before employed with greater or less success. He considers it as much superior to cinchona, on account of the certainty of its effects, and the facility with which it can be procured. This febrifuge is nothing else than *gelatine*, or common strong glue. He purifies it, mixes it with a little sugar and orange flower water, and rolls it out into large cakes, which he cuts into small squares of the size of an inch, weighing about a gros. The dose is from two gros to thirty-two, according to the age and circumstances of the patient. It is dissolved in water in such a manner that the beverage retains a considerable degree of consistence; and it is swallowed at once when the fit comes on. The same thing is repeated at the next fit, and it is seldom necessary to take a third.

The author has mentioned a number of persons to give testimony of the success of this remedy, all from the individuals who depend on his vast establishments of tanning and agriculture.

The Institute has appointed a commission, composed of Berthollet, Fourcroy, Des Essarts, and Portal, to examine the memoir, and give in a report on it after repeating the experiments.

M. Seguin has announced a series of memoirs, in which he says he will develop the whole theory of fever, determine what is the febrile principle properly so called, and what is the mode of action of febrifuge medicines. The results are waited for with a mixture of impatience and doubt.

GALVANISM.

Professor Aldini repeated his experiments on Galvanism at the Anatomical Theatre, St. Thomas's Hospital, during the last month. As the professor does not speak the English language, Mr. Astley Cooper explained to the gentlemen present. The Galvanic troughs, consisting of 120 pairs of silver

silver and zinc plates, of two inches square, with the metallic communications, were under the direction of Mr. Pepys jun.

The first series of experiments was on frogs. The head being severed, the sciatic nerves and the whole of the muscles of the thighs and legs were laid bare; a portion of the vertebræ was cut away between the two nerves, leaving a small portion as a holding part.

Exp. I. The prepared limbs being held by the portion of the vertebræ, the muscular part of the thigh or knee was brought by the operator in contact with the nerves. Contractions instantly took place without any metallic communication.

Exp. II. Two prepared frogs were laid on the surface of a dry earthen plate, the opposite knees and the vertebræs communicating; as soon as a metallic arc was made by a bow of wire, touching the nerve and muscle of one of the frogs, violent contractions took place in both.

Exp. III. Three prepared frogs were laid in the same order as in Exp. II, only the parts of the animal were not in contact, *except* by a streak of water drawn by the finger from one to the other across the plate. As soon as a metallic communication was made between the nerve and muscle of one, all the three were thrown into motion, and at the same instant. If glass bars or metallic ones with a small portion of wax on one end are used, no contractions are excited.

Exp. IV. A prepared frog being held by the foot and a portion of the vertebræ, and the other foot being brought in contact with a silver waiter, such violent contractions were excited as to cause the limb apparently to leap along the plate.

Exp. V. The operator having hold of the feet of a prepared frog with one hand, and by wetted hands communicating with three persons or more, the last person completed the circle by touching the vertebræ; in doing which contraction instantly took place.

Exp. VI. Two prepared frogs being laid in the order before mentioned on an earthen plate, a third was laid between them reversed, the toes touching the vertebræ of the two. On a metallic communication being made, the two outward ones violently contracted, without any sensible effect on the middle one, though it served as the conductor to one.

The second series was on a decapitated dog, in which the troughs were made by a flexible metallic conductor to communicate with the desired part.

Exp. VII. A wire of tin communicating with one end of the trough being introduced into the rectum of the animal, the head being placed against the severed trunk, the communication

nication was made into the ear by a wetted wire, or flexible conductor, joining the oppofite end of the troughs. The contractions were fo violent as to throw the animal forward on the table.

Exp. VIII. The communications were exactly as in the laft experiment, but the head was feparated about fix inches from the trunk, and only communicated by the moifture on the table. On forming the circle, the contractions were nearly as before.

Exp. IX. The head being removed, the communication was made with the fpinal marrow; upon which the intercoftal mufcles were excited fufficiently to exfpire and infpire the atmofpheric air with fuch force, as to blow out a lighted taper.

Exp. X. Rabbits which had been decapitated exhibited feveral of the before-mentioned phænomena. Two trunks or two heads placed together experienced contractions on the communication being made.

Exp. XI. A portion of the diaphragm being laid on an earthen plate, was fubject to contraction on the communication being made.

Exp. XII. The heart was not fubject to contraction by the Galvanic fhock; but was affected mechanically, as it ufually is by glafs, refin, or any infulating pointed body.

Exp. XIII. Galvanic attraction was made fenfible by the operator holding a prepared frog by its feet, placing the other hand on the fpinal marrow of the dog, and bringing the fciatic nerves of the frog nearly in contact with the expofed ribs of the dog: the nerves were inftantly attracted, and contraction took place.

Exp. XIV. The contraction of the pupil of the eye, by connecting the optic nerve with one end of the pile and touching the iris with the other conductor, was fhown. This experiment was propofed by Mr. Babington.

The furgeons and pupils of Guy's and St. Thomas's Hofpital very handfomely prefented the profeffor with a gold medal*, as an acknowledgement of his attention and application in elucidating feveral of thefe compound experiments to their complete fatisfaction.

* On one fide are the arms of Guy's and St. Thomas's Hofpital; on the other is the following infcription, furrounded with raifed oak leaves:

Johanni Aidino,
Præclaro Phyfico,
Digno Galvani Nepoti,
Recens Experimentis commonftratis,
Profeffores et Scholares
Nofocom. St. Thomæ et Guy.
Libenter perfolvunt.
MDCCCIII. Londini.

The

The following account of some experiments on a human subject we copy from the newspapers:

"The body of Forster, who was executed on Monday the 17th of January for murder, was conveyed to a house not far distant, where it was subjected to the Galvanic process by professor Aldini, under the inspection of Mr. Keate, Mr. Carpue, and several other professional gentlemen. M. Aldini showed the eminent and superior powers of Galvanism to be far beyond any other stimulant in nature. On the first application of the process to the face, the jaw of the deceased criminal began to quiver, the adjoining muscles were horribly contorted, and one eye was actually opened. In the subsequent part of the process, the right hand was raised and clenched, and the legs and thighs were set in motion. It appeared to the uninformed part of the by-standers as if the wretched man was on the eve of being restored to life. This, however, was impossible, as several of his friends, who were under the scaffold, had violently pulled his legs, in order to put a more speedy termination to his sufferings. The experiment, in fact, was of a better use and tendency. Its object was to show the excitability of the human frame, when this animal electricity is duly applied. In cases of drowning or suffocation, it promises to be of the utmost use, by reviving the action of the lungs, and thereby rekindling the expiring spark of vitality. In cases of apoplexy, or disorders of the head, it offers also most encouraging prospects for the benefit of mankind. The professor, we understand, has made use of Galvanism also in several cases of insanity, and with complete success. It is the opinion of the first medical men, that this discovery, if rightly managed and duly prosecuted, cannot fail to be of great, and perhaps, as yet, unforeseen utility."

To render the preceding account more interesting, we shall relate the following, either new, or not commonly known, facts.

1. Taking the cessation of excitability to the Galvanic stimulus as the criterion of life, the heart is not the *ultimum* but the *primum moriens*; for, while the muscles of the limbs were excited to strong contractions for even 7 hours' apparent death by suspension of a hot-blooded animal, the heart was utterly incapable of being excited to action, either by applying the extremity of the metallic arc to the surface or to the interior of this organ.

2. The lungs were equally inexcitable as the heart.

3. Not only were the muscles, but the skin and cellular membrane, excited to action by the Galvanic stimulus.

4. The

4. The contractions of the muscles were excited by the metallic arc or wire applied to the nerves supplying such muscles; but the nerves themselves were not affected, not even the largest nerve of the human body, the sciatic nerve.

5. Motion or raising up of the arm was produced (as if by volition) by the Galvanic stimulus.

6. A milky or coagulated matter was formed by repeated contractions of the muscle in contact with the copper wire, or wire of copper plated with silver: and the same appearance was seen when a plate of tin foil was interposed, for then this white matter was formed on this tin foil.

7. When the parts ceased to give out motion, or less motion, the motions were renewed with augmented force by wetting them with solution of sal-ammoniac.

8. It is scarcely necessary to remark, that the Galvanic stimulus excited contractions in parts which gave out no action to sulphuric acid, volatile alkali, and other stimuli.

Of the practical Uses of Galvanism.

The uses in common life of new facts are not always immediately apprehended; so that, although nothing very conclusive can be said, the present facts may be hereafter of great utility. In the meanwhile we observe:

1. That Galvanism may be a most powerful aid in restoring the vital actions suspended by submersion, by suspension, &c. although it does not act upon the lungs and heart; but if, at the same time that it excites the muscles in general, warm oxygen gas be applied to the lungs, and frictions and the hot bath be employed, much more may be effected than without Galvanism.

2. In many diseases consisting in cessation of action, the parts may be excited to action by this new stimulus, *if it be duly applied.* For this purpose a machine is required which will of itself, without manual assistance, apply effectually the Galvanic fluid for any length of time. Such an instrument has been constructed by Mr. Cuthbertson, and will no doubt hereafter be as commonly used as our present electrical machines.

3. In comparing electricity to Galvanism, it must be considered, that the former acts by its *intensity*, and the latter by its *quantity*: that the former, so intense, and sufficient if properly directed to knock a man down, shall yet not be in *quantity* enough to melt an iron wire or one of platina; but the latter shall melt these metals, yet scarcely produce a shock.

MISCELLANEOUS.

1. Hildebrandt, in a ſeries of experiments on the action of both the carbonate and pure ammonia on copper, found no ſolution take place without the preſence of atmoſpheric air. Hahnemann had aſcribed the action to the carbonic acid obtained from the air, but this he has proved is without foundation. If the oxide of copper is uſed, a blue ſolution is produced without the admiſſion of the atmoſphere.

2. According to Vauquelin, the boracite called magneſio-calcareous borate by the French chemiſts, is not a triple compound, conſiſting of boracic acid, magneſia and lime. When tranſparent and cryſtallized, he finds in it none of the latter ſubſtance, but only boracic acid and magneſia. When opake, it is rendered ſo by lime, not in chemical combination.

3. An analyſis of the waters of Plombiers, by Vauquelin, gives per pint:

1 gr. 1-6th of ſulphurated ſoda.
5-8ths of muriated ſoda.
2-3ds of ſilex.
1-4th of carbonate of lime.
1 gr. 1-12th of carbonate of ſoda.
1-half of animal matter.

This animal matter is like albumen, and is only held in ſolution by the ſoda; as an acid inſtantly ſeparates it, and cauſes it to precipitate.

4. Brugnatelli recommends nitric ether to be prepared in the following way:—Into a tubulated retort put one ounce of ſugar and two ounces of alcohol: to the retort adapt a large receiver covered with wet cloths; ſecure the joint with paſted paper, then pour in three ounces of concentrated nitric acid by the tubulure: ebullition takes place, and an excellent ether of an orange colour paſſes into the receiver, which will not redden vegetable blues: as ſoon as the ether is all received, nitrous gas is evolved: the receiver muſt be immediately changed. By treating the reſiduary ſugar with more nitric acid, oxalic acid very pure will be obtained.

5. Mr. Dabit, in the *Annales de Chimie*, No. 127, gives an account of ſome experiments on the reſiduum of ſulphuric ether, from which he is induced to believe, that he has diſcovered an acid of ſulphur in a ſtate of oxygenation intermediate between the ſulphuric and ſulphureous acids. As yet he has not obtained it in a free ſtate; and he founds his

 concluſions

concluſions upon the phænomena preſented by its ſaline compounds.

In ſaturating the reſiduum of ether, mixed with water, with carbonate of lime, he obtained a ſolution which gave by evaporation a ſalt that cryſtallized in parallelopipeds, having but little taſte, and being ſoluble in 100 parts of cold water. This ſalt was decompoſed by ſulphuric acid. By the action of oxygen gas, or of nitrous acid, it was converted into ſulphate of lime; and, by being heated with charcoal, it gave a ſulphuret of lime.

When it was mixed with a ſolution of carbonate of potaſh, ſoda, or ammoniac, a double decompoſition took place, and the ſtronger acid combined with the alkalies.

Mr. Dabit has noticed ſome of the properties of its alkaline combinations, which are extremely analogous to thoſe of the ſulphites. He propoſes to call the acid the oxygenated ſulphureous acid. But the application of the name will moſt probably be generally conſidered as premature; and new characters will be required to diſtinguiſh it from the ſulphureous acid, before its exiſtence as a peculiar body can be implicitly admitted.

6. Dr. Benzenberg, in an eſſay on the improvement of object glaſſes for teleſcopes*, warmly recommends that the glaſs be ſuffered to cool in the pots without ſtirring, and that the maſs be then divided in a horizontal direction, ſo that the variation of denſity may be regular, and then, by a proper form of the glaſſes, the errors of refraction may be corrected. The idea is not new, but it does not appear to have been carried into practice. Dr. Benzenberg conſiders achromatic teleſcopes as promiſing much more than reflectors, and thinks that they intercept much leſs light.

7. Mr. Sprenger of Jever gives an account† of his method of adminiſtering Galvanic electricity in caſes of deafneſs. A ſmall ball is applied to the external orifice of the ear, and a much larger one is held in the patient's hand; the communication is then formed and interrupted alternately by means of machinery, once in every ſecond, for about four minutes daily, for a fortnight or more. He aſſerts that he has thus reſtored the ſenſe of hearing to forty-five perſons, and to four of them that of ſmell alſo. All who were completely deaf experienced relief, almoſt without exception; but a partial deafneſs did not appear to receive the ſame benefit. The ear was filled with wool, to avoid taking cold. The degree of advantage obtained was eſtimated by an inſtrument invented

* Gilbert's Annals. † Ibid.

by

by Profeſſor Wolke, in which a hammer falls from a certain point of a quadrant, ſo as to ſtrike an elaſtic plate with a velocity capable of preciſe determination. Theſe experiments relate to a ſubject ſo important that they muſt not be paſſed unnoticed, however improbable it may appear that Galvanic electricity ſhould have any material advantage over electricity otherwiſe excited, and however we may be diſpoſed to believe the report of other obſervers, that the relief is in general inconſiderable and only temporary.

ARTIFICIAL COLD.

Mr. Lowitz *(Journal de Chimie et de Phyſique*, by Van Mons,) concludes, from various experiments on artificial cold, of which a particular account is to be publiſhed in the Tranſactions of the Academy of Peterſbourg,

1. That the principal cauſe of the cold produced during the ſolution of ſalts in water, depends upon ſome agency of their water of cryſtallization; for ſalts deprived of this water, inſtead of producing cold, produce heat.

2. Amongſt the liquid acids, the muriatic acid is moſt efficacious for forming freezing mixtures; the nitrous acid is next to it in order; and the ſulphuric acid is leaſt powerful.

3. The liquid acids produce cold only becauſe they occaſion a quick ſolution of the ſnow, or ſalt, of the freezing mixture.

4. Cauſtic potaſh and the muriate of lime ſurpaſs very much, as cooling agents, the acids and the other ſaline ſubſtances.

5. The beſt proportion of the mixture of ſnow and muriate of lime, is two parts of the firſt to three parts of the laſt, mixed as accurately as poſſible.

6. Five pounds of muriate of lime are ſufficient to freeze thirty-five pounds of mercury.

7. The deliqueſcent ſalts are much more proper for producing cold than the efflureſcent ſalts.

8. That the deliqueſcent ſalts may produce the higheſt poſſible degree of cold, it is neceſſary that they contain the greateſt poſſible quantity of water of cryſtallization; and that they be uſed in fine powder.

9. The ſnow employed ſhould be that which has newly fallen, light and dry; and the experiments ſhould be made at the commencement of a froſt, and not during a thaw.

10. It appears that the ſuperiority of the deliqueſcent ſalts to the acids is owing to the circumſtance of their becoming

coming fluid at the ſame time that they cauſe the ſnow to diſſolve.

11. Cauſtic potaſh and muriate of lime poſſeſs, amongſt other advantages, that of being eaſily reſtored, unaltered, to their ſolid ſtate, after an experiment, by evaporation.

PRESERVING ANIMAL SUBSTANCES.

Mr. Chauſſier employs, for preſerving animal matters from putrefaction, a ſolution of oxygenated muriate of mercury, kept conſtantly in a ſtate of ſaturation. The preparations remain immerſed in it for a certain number of days; and, after they are thoroughly impregnated with it, may be dried by expoſure to light and air. After the proceſs, they are no longer ſuſceptible of being eaſily decompoſed; they preſerve their form, become poſſeſſed of a great degree of hardneſs, and are not ſubject to the attacks of inſects.

HUMBOLDT'S TRAVELS.

The *Berliniſche Monatſchreft*, a journal publiſhed monthly at Berlin, contains an intereſting extract of a letter from M. Alexander von Humboldt, in which he gives an account of the progreſs of his travels through South America. It is written from Contreras, near Ibagua in New Grenada. Before he left Carthagena he paid a viſit to the foreſt of Turbaco, celebrated for the ſize of its trees: ſome of them are eight feet in diameter, and are of the kind named *cavanilleſia mocondo*, before obſerved by Jacquin, who travelled in the time of Francis I. M. von Humboldt, who had propoſed to go to Peru, could not reſiſt the deſire he entertained of proceeding to Santa-Fé-de-Bajota to ſee the celebrated botaniſt Mutis, 72 years of age, and one of the friends of Linnæus.

Thus, inſtead of proceeding by ſea to Guayaquil, which was much more convenient, he purſued the route to Quito by land through Santa-Fé. He firſt navigated, for forty-five days, along the river De la Madelaine, amidſt the moſt dreadful tempeſts and the moſt dangerous cataracts. During this part of his journey he conſtructed a topographical chart of the country on four folio ſheets, a copy of which was kept by the viceroy. When he arrived at Honda, in five degrees north latitude, he viſited the mines of Mariquita and Sainte-Anne. In that country he found conſiderable plantations of cinnamon and nutmeg-trees; and whole foreſts of the tree which furniſhes cinchona, and of the almond-tree, called by botaniſts *caryocar amygdaliferum*.

M. von Humboldt was at that time accompanied by a young

young Frenchman named Deſieux, to whom the Spaniſh government had entruſted the care of theſe plantations. Our travellers at length reached the entrance of the Cordilleras (*la Bocca del Monte*), climbed up the firſt eminences, and came to the plain of Bajota, one of the higheſt of the globe. This plain was formerly a lake, containing a ſurface of 32 ſquare leagues: in the middle of it is ſituated the town of Santa-Fé. M. von Humboldt was received here as if in triumph: ſixty perſons on horſeback came to meet him; and the venerable Mutis had prepared a houſe for him near to his own. The king of Spain devotes 10,000 piaſtres per annum to this botanical eſtabliſhment. For fifteen years paſt, thirty draftſmen have been employed in it under the direction of Mutis. They have executed 3000 drawings in folio, which are finiſhed with all the delicacy of miniature painting. M. von Humboldt could compare the botanical collection of Don J. Celeſtino Mutis only to that of Sir Joſeph Banks. M. von Humboldt meaſured the altitude of the mountains which ſurround Santa-Fé, ſeveral of which riſe to the height of 2000 and 2400 toiſes. From Santa-Fé he was to proceed to Quito, and thence to Lima. He was to be at Acapulco in the month of May laſt year, and, after travelling through Mexico, he was to return to Europe by the Philippines and the Cape of Good Hope. Such a journey, undertaken by ſo enlightened a man, promiſes the happieſt reſults to ſcience.

SALTS OF IRON*.

The ſulphate, muriate, and acetite of iron, at their minimum of oxidation, may be obtained in a very eaſy manner by means of the artificial ſulphuret of iron. When artificial ſulphuret of iron is acted upon by muriatic acid, or ſulphuric acid in a ſtate of dilution, or acetous acid, the ſulphureted hydrogen gas, diſengaged during the proceſs of ſolution, prevents any hyper-oxygenated ſalt from being formed by the action of the atmoſphere; and a clear fluid, in all caſes, of a ſhade of green, is obtained, which, when freed by heat from any ſulphureted hydrogen diſſolved in it, gives a perfectly white precipitate with the alkaline pruſſiates, and is not found to alter the colour of ſolution of galls.

To form the leaſt oxygenated nitrate of iron, by means of the artificial ſulphuret, an acid of a ſpecific gravity not greater than 1·12 muſt be uſed; and the ſolution muſt be made without the aſſiſtance of heat. After having been freed from ſulphurated hydrogen, by being boiled for a minute or two, and

* From *Journals of the Royal Inſtitution of Great Britain.*

then filtrated, it is found similar in its colour and physical properties to the weakeſt ſolutions of the other oxygenated ſalts.

When the ſulphate and muriate of iron, at the minimum of oxidation, are obtained in the ſolid form, by evaporation from their ſolutions, they appear in regular cryſtals, which in each ſalt are a different ſhade of a very pale green colour; their taſtes are exactly ſimilar, being aſtringent, and leaving in the mouth the ſenſation of ſweetneſs.

The leaſt oxygenated nitrate of iron cannot eaſily be procured pure in the cryſtallized ſtate; for when the ſolution of it is heated for any length of time, a new arrangement of its principles takes place; portions of the acid and of the water of the ſolution are decompoſed; in conſequence of which ammoniac is formed; and an oxygenated nitrate of iron, with exceſs of baſe, is depoſited.

Amongſt the ſalts of iron, at the minimum of oxidation, I have found the muriate the moſt convenient for exhibiting the experiments of Prouſt, and in eudiometrical proceſſes with nitrous gas. It is more ſoluble in water than the ſulphate, and very much more ſoluble in alcohol. D.

ERRATUM.

Page 82, lines 3 and 4, for "organ of inſtinct *and*," read "organ of inſtinct *of*."

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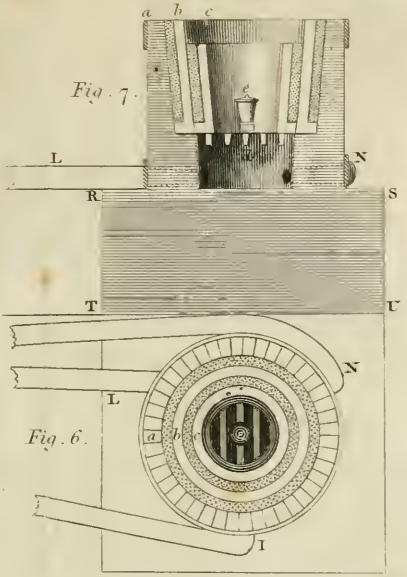

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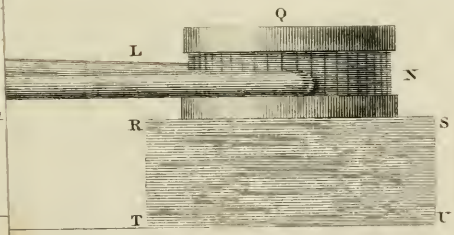

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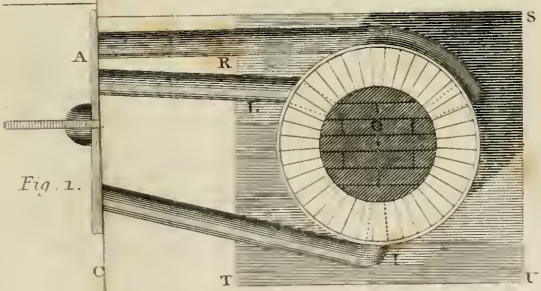

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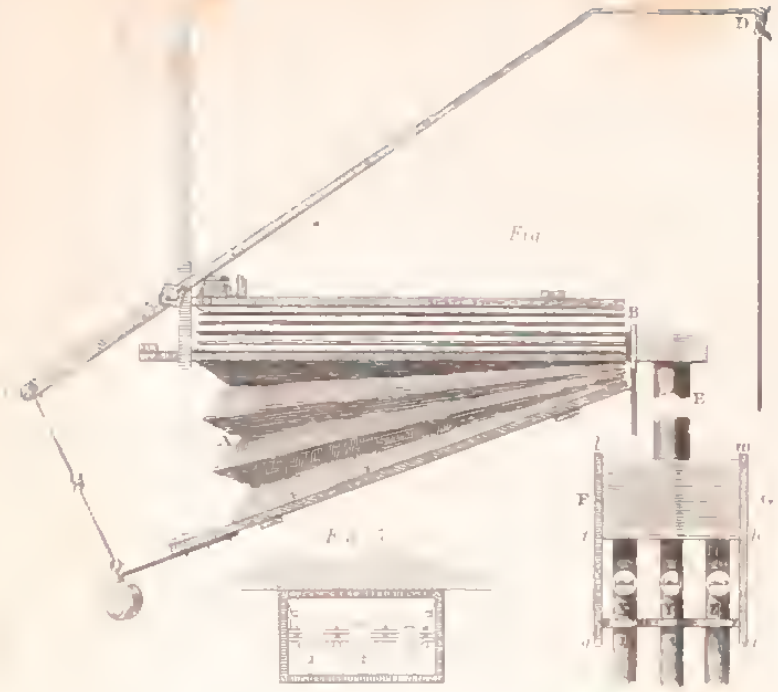

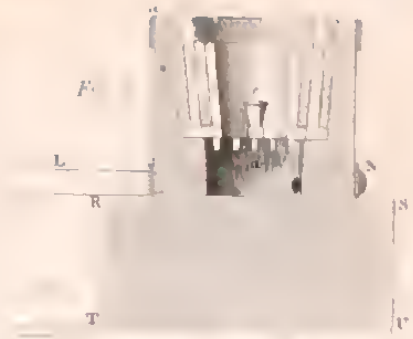

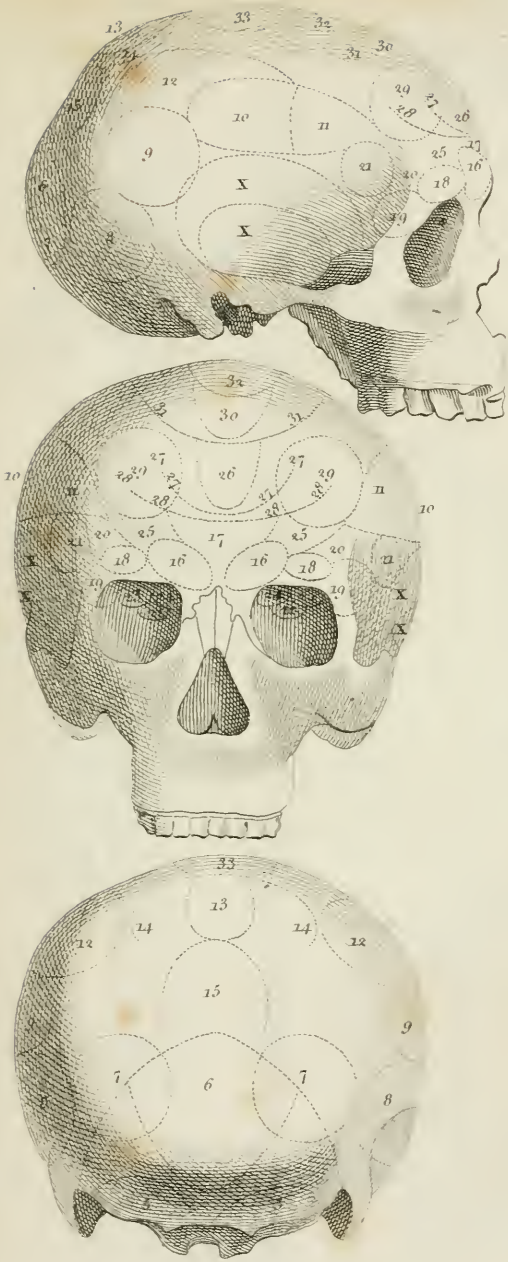

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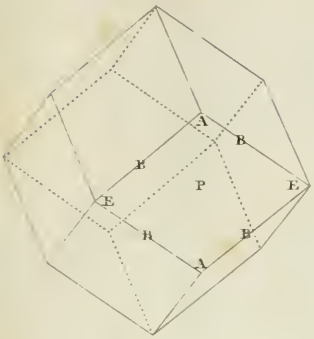

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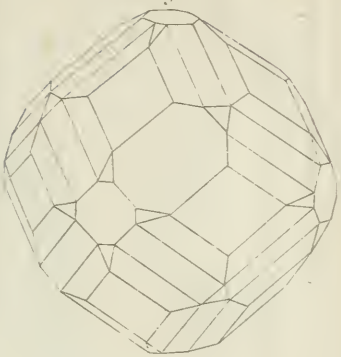

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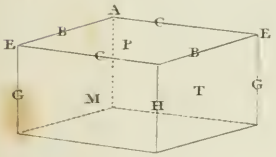

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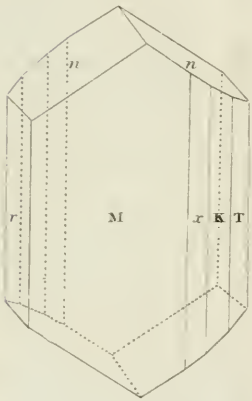

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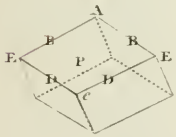

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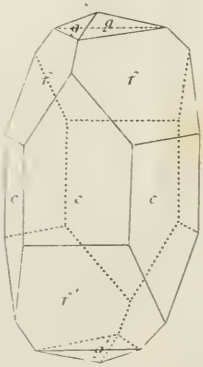
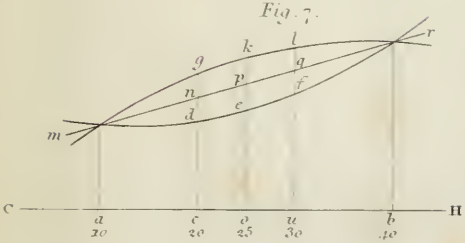
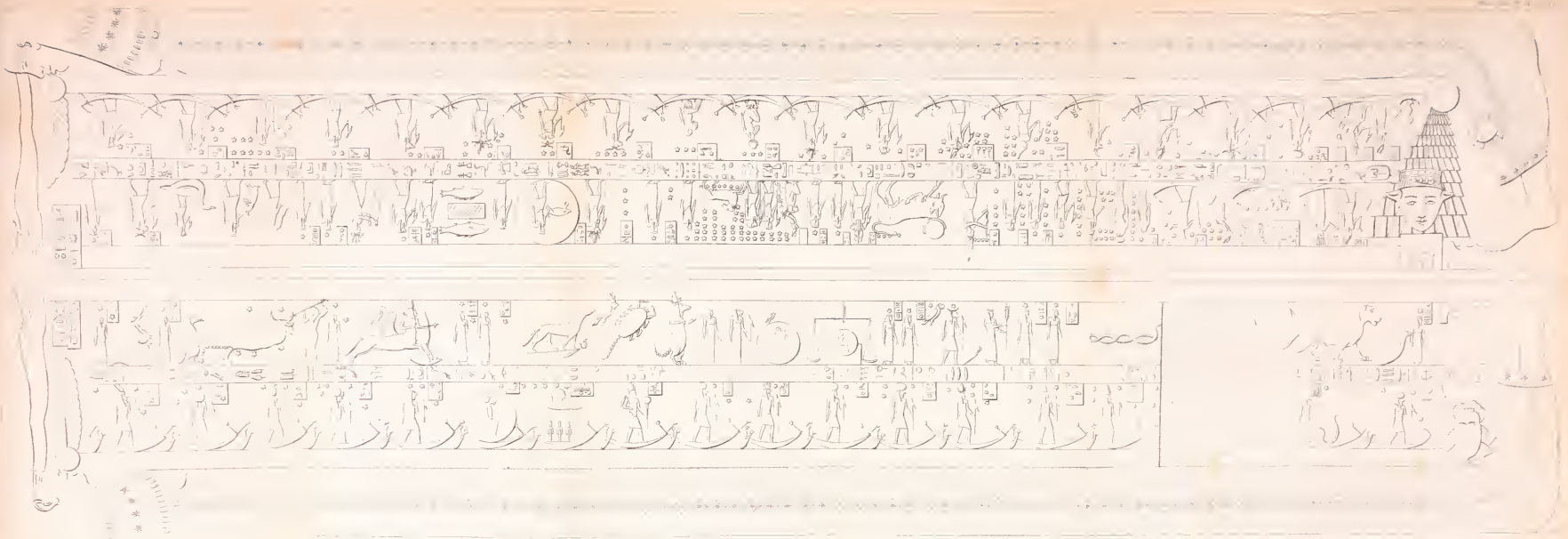
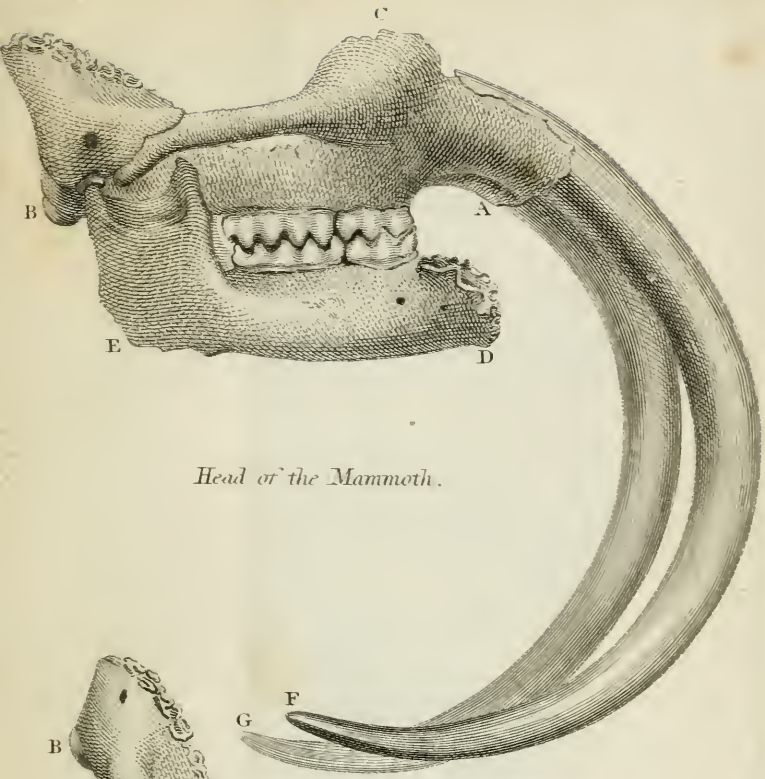


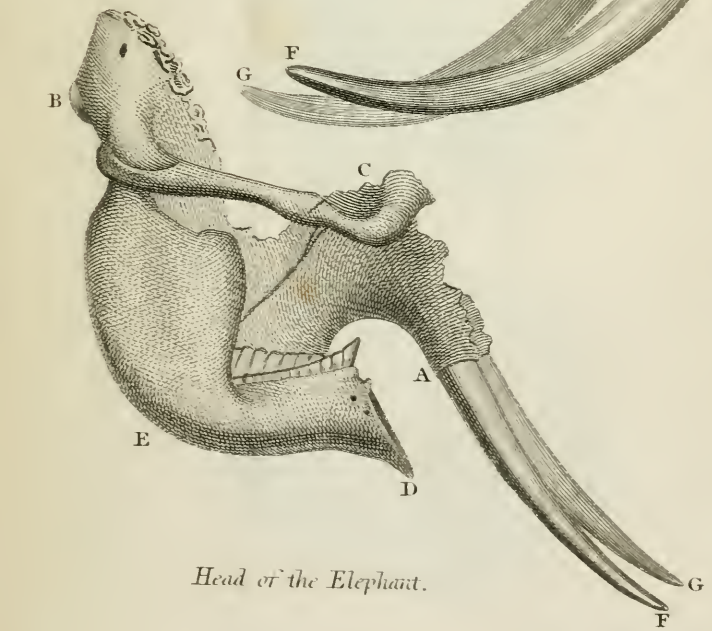
Fig. 7.







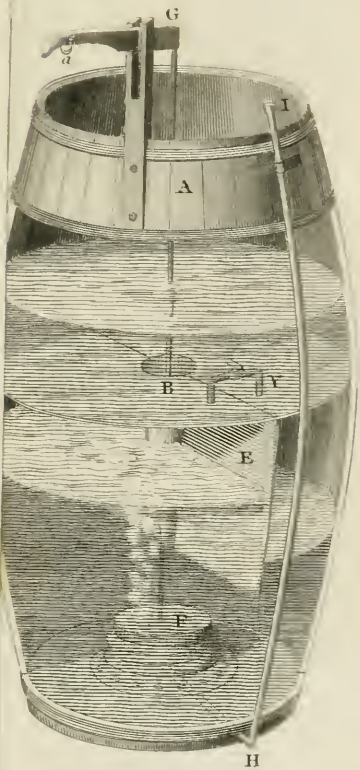
Head of the Mammoth.

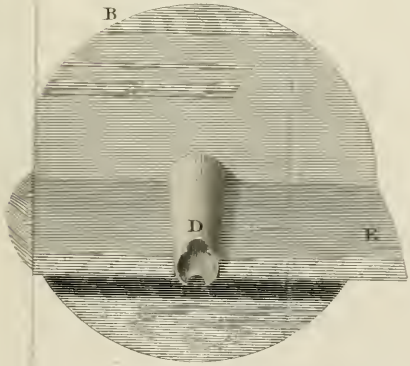


Head of the Elephant.

Lowry, sc.

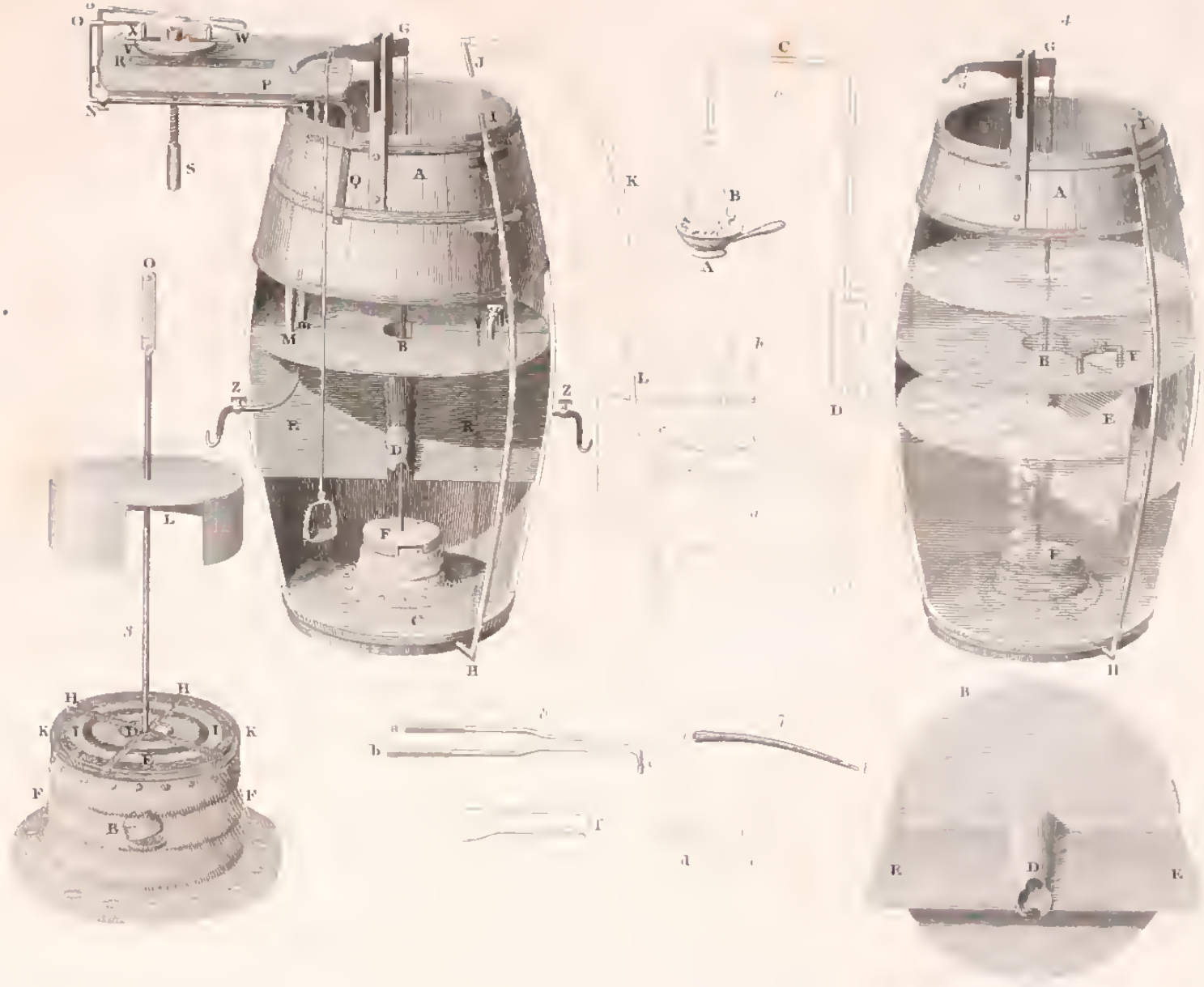
4.





2.

Lowry sculp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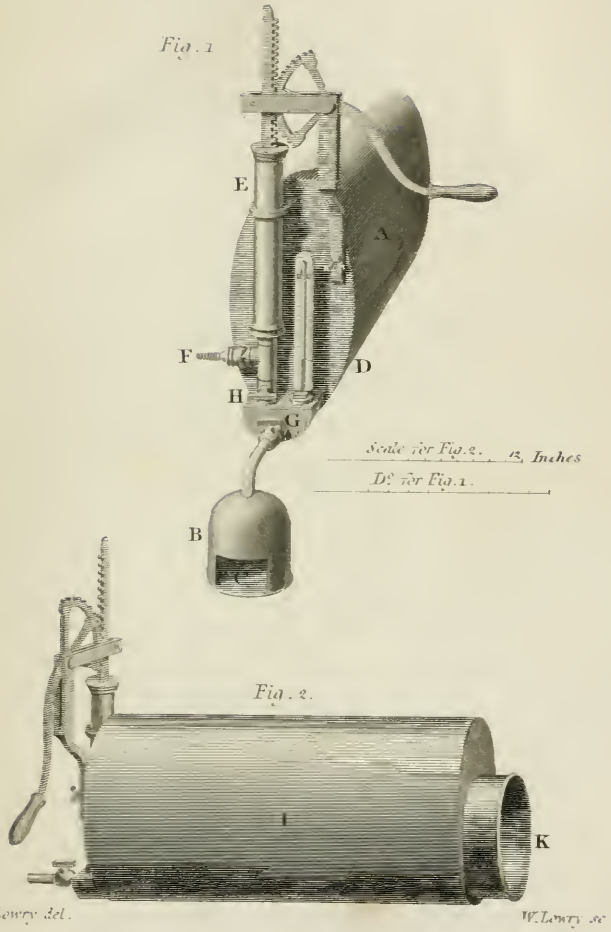
Fig. 1
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Scale for Fig. 2. 12 Inches
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Matilda Lowry del.
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